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A Continuing Bibliography with Indexes

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A Continuing Bibliography with Indexes

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NASA SP-7037(200)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 200)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in April 1986 in

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*

NASA Scientific and Technical Information Branch 1986
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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 484 reports, journal articles, and other documents originally announced in April 1986 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes -- subject, personal author, corporate source, foreign technology, contract number, report number, and accession number -- are included.

An annual cumulative index will be published.

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Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

Category 14 Life Sciences 260
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Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

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AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 200)

MAY 1986

01

AERONAUTICS (GENERAL)

A86-21055
AVIATION MAINTENANCE MANAGEMENT
E. H. KING (Southern Illinois University, Carbondale, IL) Carbondale, IL, Southern Illinois University Press, 1986. 221 p. refs

The maintenance management concerns that confront the various levels of aviation supervision are discussed. The topics addressed include: the FAA's organizational structure, FAA publications pertaining to maintenance, aviation maintenance procedures, the application of aviation maintenance concepts, and budgeting, cost controls, and cost reduction. Also considered are: training and professional development in aviation maintenance, safety and maintenance, electronic data processing, and aviation maintenance management problem areas. C.D.

A86-21325
GENERAL AVIATION AND REGIONAL AIR TRAFFIC - COMPONENTS OF THE TRAFFIC SYSTEM, SYMPOSIUM, FRIEDRICHSHAFEN, WEST GERMANY, MARCH 28, 29, 1985, REPORTS [DIE ALLGEMEINE LUFTFAHRT UND REGIONALLUFTVERKEHR BESTANDTEILE DES VERKEHRSSYSTEMS, SYMPOSIUM, FRIEDRICHSHAFEN, WEST GERMANY, MARCH 28, 29, 1985, VORTRAEGE]
Symposium sponsored by DGLR, DGON, and BMFT. Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1985, 196 p. In German. No individual items are abstracted in this volume.

The airport system in the Federal Republic of Germany is considered, taking into account 11 international airports, 30 smaller airports, air traffic requirements, the importance of general aviation and regional air traffic for the economy, and the significance of smaller airlines that can provide cost-effective air transportation for regions and cities which cannot be profitably serviced by the big airliners of the large airlines. Attention is given to the role of the Lufthansa in the regional air traffic of West Germany, the regional air traffic from the point of view of the European Regional Airlines Organization (ERA), observations made in connection with regional air traffic, the effect of regional air traffic on the region in which the airport is located, observations made in an airport with respect to air traffic control, and requirements related to runways in case of instrument flight operations at regional airports. The political and economic significance of air traffic involving business aircraft is considered along with the availability of the Global Positioning System. G.R.

A86-21894#
TOWARD AUTOMATED AIRFRAME ASSEMBLY
W. H. REIMANN (USAF, Manufacturing Technology Div., Wright-Patterson AFB, OH) Aerospace America (ISSN 0740-722X), vol. 24, Jan. 1986, p. 44-46, 48.

The U.S. Air Force has been supporting research on flexible automated systems for airframe assembly over the course of several years. Attention is given to the use of two robots to inspect F-15 fighter airframe bulkheads, reducing the current 25-hr process in which 1100 measurements are conducted to a 2.5-hr one. Also noted is the robotic assembly of a microswitch from 17 parts that have been positioned randomly on a tray. Also sponsored are two programs on flexible assembly subsystems that are developing the technologies required by an Automated Assembly Center, such as flexible fixturing, part-location sensing, and temporary/permanent fastening of parts. O.C.

A86-22128
EVOLUTION OF AIRCRAFT/AEROSPACE STRUCTURES AND MATERIALS SYMPOSIUM, DAYTON, OH, APRIL 24, 25, 1985, PROCEEDINGS
Symposium sponsored by AIAA. Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, 137 p. For individual items see A86-22129 to A86-22144.

Various papers on the evolution of aircraft and aerospace structures and materials are presented. The topics addressed include: XB-70 structures and materials advances, structural evolution from B-58 to F-16, advanced composites in construction of the Beech Starship, structural and material considerations for advanced fighters, the evolution of reciprocating engines at Lycoming, aircraft design from the myth of make-do to Mach 3, and the Wright Brothers' experience in the evolution of aircraft design, structures and materials. Also considered are: evolution of the turbofan aircraft engine, X-15 high-temperature advanced structure, X-20 structures overview, ASSET program for technology development, Shuttle Orbiter airframe, airframe design to achieve minimum cost, superplastically formed-diffusion bonded titanium technology transition case study, transition of advanced materials and structures in single crystal blades, and composites technology transfer and transition. C.D.

N86-16187*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
VORTEX WAKE ALLEVIATION STUDIES WITH A VARIABLE TWIST WING
G. T. HOLBROOK, D. M. DUNHAM, and G. C. GREENE Nov. 1985 117 p refs
(NASA-TP-2442; L-15870; NAS 1.60:2442) Avail: NTIS HC A06/MF A01 CSCL 01B

Vortex wake alleviation studies were conducted in a wind tunnel and a water towing tank using a multisegmented wing model which provided controlled and measured variations in span load. Fourteen model configurations are tested at a Reynolds number of one million and a lift coefficient of 0.6 in the Langley 4- by 7-Meter Tunnel and the Hydronautics Ship Model Basin water tank at Hydronautics, Inc., Laurel, Md. Detailed measurements of span load and wake velocities at one semispan downstream correlate well with each other, with inviscid predictions of span load and wake roll up, and with peak trailing-wing rolling moments measured in the far wake. Average trailing-wing rolling moments are found to be an unreliable indicator of vortex wake intensity because vortex meander does not scale between test facilities and free-air conditions. A tapered-span-load configuration, which exhibits little or no drag penalty, is shown to offer significant downstream wake alleviation to a small trailing wing. The greater downstream wake alleviation achieved with the addition of spoilers to a flapped-wing configuration is shown to result directly from the high incremental

drag and turbulence associated with the spoilers and not from the span load alteration they cause. Author

N86-16188# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).
AIR AND SPACE FLIGHT. DREAM AND FACTS [LUFT- UND RAUMFAHRT. TRAUM UND WIRKLICHKEIT]
L. BOELKOW, K. VONGERSDORFF, and H. J. EBERT 1985 32 p In GERMAN Presented at the opening of the Air and Space Travel Hall of the Deutsches Museum, Munich, West Germany, 6 May 1984 and at Bayerischer Verdienstorden, 20 Jul. 1984
(MBB-FILM-382) Avail: NTIS HC A03/MF A01

The history of man's conquest of the air and space with hot air balloons, subsonic and hypersonic aircraft, helicopters and gliders as well as rockets, space shuttles, and manned space flights is reviewed. Progress in aircraft and space technology is discussed. Author (ESA)

N86-16189# Rijksluchtvaartdienst, The Hague (Netherlands).
ACTIVITIES REPORT IN AERONAUTICS Annual Report, 1984 [JAARVERSLAG 1984]
1984 62 p In DUTCH
Avail: NTIS HC A04/MF A01

The activities of the Dutch Civil Aeronautics Board (CAB) are reviewed. Air traffic control, airfields, air transportation, aviation security, aviation school, national aeronautics and astronautics museum, and national aeronautics and astronautics laboratory are presented. Regional services in Europe; an aviation accident law; Maastricht airport; and recognition of industries by the CAB are discussed. Author (ESA)

N86-16190# Societe Nationale Industrielle Aerospatiale, Suresnes (France). Lab. Central.
PROBLEMS FOUND WHEN INTRODUCING NEW MATERIALS [PROBLEMES POSES PAR L'INTRODUCTION DES MATERIAUX NOUVEAUX]
G. HILAIRE 29 Apr. 1985 34 p In FRENCH Presented at Journees de la Technologie 1984, Jonville, France, 5-6 Dec. 1984
(SNIAS-852-551-101; C-47-652-AC/GH-AT) Avail: NTIS HC A03/MF A01

Aircraft specifications and design problems are discussed. The parameters guiding the choice of new materials are analyzed. Organic matrix composite materials, carbon or glass, aluminum lithium alloys, titanium alloys and metallic matrix composites are examined. The effect of a new material on the aircraft life and maintenance and operation cost is discussed. Fatigue problems and lithium alloys are studied. Author (ESA)

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A86-19631#
AN EXPERIMENTAL INVESTIGATION OF AN AIRFOIL PITCHING AT MODERATE TO HIGH RATES TO LARGE ANGLES OF ATTACK
G. M. GRAHAM and J. H. STRICKLAND (Texas Tech University, Lubbock) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 7 p. Research supported by the Sandia National Laboratory. refs
(Contract F49620-82-C-0035)
(AIAA PAPER 86-0008)

Flow visualization data, surface pressure distributions, and load cell data were obtained from a NACA 0015 airfoil undergoing constant pitch motions over a wide range of nondimensional pitch rates. In each case, the motion began at 0 deg angle-of-attack, and terminated when the airfoil reached 90 deg angle-of-attack. It was found that lift and drag coefficient data could be correlated using simple trigonometric functions. These correlations in turn allow one to estimate lift and drag coefficients over the entire range of motion for any nondimensional pitching rate. Author

A86-19633*# Informatics General Corp., Palo Alto, Calif.
UNSTEADY TRANSONICS OF A WING WITH TIP STORE
G. P. GURUSWAMY (Informatics General Corp., Palo Alto, CA), P. M. GOORJIAN (NASA, Ames Research Center, Moffett Field, CA), and E. L. TU AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 14 p. USAF-supported research. refs
(AIAA PAPER 86-0010)

The presence of tip stores influences both the aerodynamic and the aeroelastic performance of wings. Such effects are more pronounced in the transonic regime. In this study, a theoretical method is developed, for the first time, to compute unsteady transonics of oscillating wings with tip stores. The method is based on the small-disturbance, aerodynamic equations of motion from the potential-flow theory. To validate the method, subsonic and transonic aerodynamic computations are made for a lower-aspect-ratio wing, and they are compared with the available experimental data. Comparisons are favorable. The strong effects of the tip store on the transonic aerodynamics of the wing are also illustrated. The method developed in this steady can be used for transonic, aeroelastic computations of wings with tip stores. Author

A86-19635#
OSCILLATING HOT-WIRE MEASUREMENTS ABOVE AN FX63-137 AIRFOIL
W. S. SARIC (Arizona State University, Tempe) and J. D. CROUCH AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 13 p. refs
(Contract N00014-84-K-0093; N00014-85-K-0527)
(AIAA PAPER 86-0012)

A system is developed to allow measurement of both the mean and disturbance flow velocities in separated regions. An oscillation arm assembly is developed which provides a directional bias to the hot-wire probe, along with a linear step assembly, which steps the probe through the boundary layer. A series of velocity profiles are measured on the FX63-137 airfoil in the chord Reynolds number range of 150,000 to 300,000, at angles of attack of alpha = 12 deg and alpha = 14 deg. Data are presented on the size of the separation bubble and on the location of transition to turbulence. Author

A86-19676*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
NUMERICAL MODELING OF ROTOR FLOWS WITH A CONSERVATIVE FORM OF THE FULL-POTENTIAL EQUATIONS
R. C. STRAWN (NASA, Ames Research Center, Moffett Field, CA) and F. X. CARADONNA (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0079)

A computer program has been developed to solve a three-dimensional conservative formulation of the full-potential equation. Its ability to solve transonic, unsteady rotor flows is demonstrated by comparison to forward flight non-lifting pressure data at low to moderate advance ratios. A 'split potential' formulation has been added to the code which incorporates known vorticity fields into the full-potential calculation. Using this methodology, rotor wake contributions have been incorporated into the computer code. Pressure results are presented for lifting rotors in hover. These results are compared to experimental data as well as to other predictions. Author

A86-19693*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE COMPUTATION OF STEADY 3-D SEPARATED FLOWS OVER AERODYNAMIC BODIES AT INCIDENCE AND YAW
T. H. PULLIAM (NASA, Ames Research Center, Moffett Field, Stanford, CA) and D. PAN AIAA, Aerospace Sciences Meeting, 24th, Reno, NV. Jan. 6-9, 1986. 12 p. refs
(Contract NCA2-IR-745-404)
(AIAA PAPER 86-0109)

This paper describes the implementation of a general purpose 3-D NS code and its application to simulated 3-D separated vortical flows over aerodynamic bodies. The thin-layer Reynolds-averaged NS equations are solved by an implicit approximate factorization scheme. The pencil data structure enables the code to run on very fine grids using only limited incore memories. Solutions of a low subsonic flow over an inclined ellipsoid are compared with experimental data to validate the code. Transonic flows over a yawed elliptical wing at incidence are computed and separations occurred at different yaw angles are discussed. Author

A86-19696#
INFLUENCE OF EXCITATION ON COHERENT STRUCTURES IN REATTACHING TURBULENT SHEAR LAYERS
F. W. ROOS and J. T. KEGELMAN (McDonnell Douglas Research Laboratories, St. Louis, MO) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. Research supported by McDonnell Douglas Corp. refs
(AIAA PAPER 86-0112)

A series of experiments was performed in the reattaching turbulent shear layer produced by flow over a backward-facing, two-dimensional step. Gentle excitation of the shear layer by an oscillating flap at the step lip proved to be highly effective in regularizing and enhancing the formation and development of vortical structures in the reattaching flow. Effects of variations in excitation amplitude and frequency were defined. An excitation-frequency-sensitive reduction in reattachment length was identified with the process of vortical-structure coalescence in the shear layer upstream of reattachment. Shear-layer excitation was shown to increase the intensity of reattachment-wall pressure fluctuations in all cases, regardless of the reattachment-length effect. Subharmonic phase-modulation of the shear-layer excitation was demonstrated to be effective in regularizing the vortex-merging process in the reattaching shear layer. Author

A86-19697#
COMPUTATION OF DYNAMIC STALL OF NACA0012 AIRFOIL BY BLOCK PENTADIAGONAL MATRIX SCHEME
Y. SHIDA, H. TAKAMI, K. KUWAHARA (Tokyo, University, Japan), and K. ONO (Nihon University, Tokyo, Japan) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(AIAA PAPER 86-0116)

The flow field around an oscillating NACA0012 airfoil in pitch at 0.25 chord is analyzed by solving the two-dimensional compressible Navier-Stokes equations. A block pentadiagonal matrix scheme based on the approximate factorization method is adopted. Two kinds of mesh, 161 x 40 and 321 x 80, are used. In the case of coarse mesh, lift stall is captured. In the case of fine mesh, not only lift stall but also restoration process of the lift coefficient in the downstroke is captured. The process of the beginning of separation at stall stage is intensively studied.
Author

A86-19698#
LIFT-CURVE CHARACTERISTICS FOR AN AIRFOIL PITCHING AT CONSTANT RATE
E. J. JUMPER (USAF, Institute of Technology, Wright-Patterson AFB, OH), S. J. SCHRECK (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH), and R. L. DIMMICK AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(AIAA PAPER 86-0117)

Daley and Jumper (1984) have conducted an experimental study of dynamic stall for an airfoil pitching at constant rates. The present paper provides a report on a systematic study of the dynamic-stall event in the case of an airfoil which pitches at a constant rate. A total of 100 dynamic-stall data runs were made at five tunnel speeds in the range of flow velocities from 26 to 48 ft/s. At each tunnel speed four pitch rates were used. Attention is given to details regarding the experimental approach, the obtained results, lift-curve characteristics, preseparation characteristics, drag and moment characteristics, and general comments. It is believed that the results reported provide insight into the mechanisms at work in the dynamic-stall process. It is emphasized that different mechanisms are at work at different points in the dynamic-stall event. G.R.

A86-19699#
VORTICES PRODUCED BY AIR PULSE INJECTION FROM THE SURFACE OF AN OSCILLATING AIRFOIL
M. C. ROBINSON and M. W. LUTTGES (Colorado, University, Boulder) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 14 p. refs
(Contract AF-AFOSR-81-0037)
(AIAA PAPER 86-0118)

High rates of vortex production are not consistent with the airfoil oscillation rates needed to match realistic, higher Reynolds numbers. Thus, alternative mechanisms must be evolved for the control and generation of large scale vortices which can yield significant amounts of lift enhancement. The present study is concerned with a noval means for producing large scale vortices over a dynamically pitching airfoil. A pulse of air is delivered during each cycle of the sinusoidal pitch oscillation. The pulse produces a brief stream of air arising from a span oriented slot located at 0.1c parallel to the leading edge. Experiments were conducted on an NACA 0015 airfoil with six inch chord in a subsonic, low turbulence wind tunnel. Attention is given to experimental details, unsteady flow visualization, the development of pulse vortices, and hot wire anemometry of flow with and without air pulse injection. G.R.

A86-19700#
FLUID DYNAMICS OF CYLINDER RESPONSE TO KARMAN VORTEX SHEDDING
L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(AIAA PAPER 86-0119)

The fluid mechanics of cylinder response to Karman vortex shedding are composed of three district flow phenomena: (1) the vortex wake formation, (2) the coupling between flow separation and body motion, and (3) the interaction between shed vortices and the body cross-section. Analysis of available experimental results for circular and rectangular cross-section cylinders shows that, for small amplitudes, (1) is the dominating flow mechanism, and the cylinder response is of the resonant type. However, when the amplitude exceeds a few percent of the cylinder crossflow dimension, the dominating flow mechanism is (2), and the cylinder response changes from the resonant to the self-excited type typical for systems with nonlinear negative damping. Flow mechanism (3) appears only to be important if the cross-section has a suitable chordwise extent, as in the case of the rectangular cross-sections. Author

A86-19702#
STEADY AND UNSTEADY FULL POTENTIAL CALCULATION FOR LARGE AND SMALL ASPECT RATIO SUPERCRITICAL WINGS
S. Y. RUO, J. B. MALONE (Lockheed Georgia Co., Marietta, GA), and L. N. SANKAR (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p. refs
(AIAA PAPER 86-0122)

A numerical method which solves the three-dimensional full-potential equation by a strongly implicit, approximate factorization algorithm is used to analyze the flow over a high and a low aspect ratio wing. Steady and unsteady flow analyses are respectively obtained by relaxation and time-accurate marching.

Numerical results are compared with the available experimental data. Author

A86-19730*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SUMMARY OF A HIGH SUBSONIC FORCE/PRESSURE EXPERIMENT FOR 58 DEG CAMBERED/TWISTED THICK DELTA WINGS
J. CHU and J. E. LAMAR (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0169)

This paper summarizes the results of a force, moment, and pressure experiment involving six thick, cambered and twisted, delta wings with 58 deg leading-edge sweep. This experiment was conducted in the NASA Langley 7- by 10-foot High-Speed Tunnel at Mach numbers of 0.75, 0.80, and 0.83. The design goal was a configuration which was self-trimming at a lift coefficient of 0.25 and Mach number of 0.80. Although the design goal was not met, the configuration which came closest and which had the best overall performance was selected for further study. Wing surface pressure data and limited surface oil flow data for this configuration are presented to show the extent of attached flow at the design point. For selected cases, inviscid solutions from vortex lattice method/suction analogy, PAN AIR, FLO-28, and FLO-57 are compared with the experimental force, moment, and pressure data. Author

A86-19731#
ACOUSTIC AND TURBULENCE INFLUENCES ON STALL HYSTERESIS
J. F. MARCHMAN, III, V. SUMANTRAN, and C. G. SCHAEFER (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(Contract N0014-84-K-0093)
(AIAA PAPER 86-0170)

The results of past research on the low Reynolds number aerodynamic behavior of the Wortmann airfoil have revealed differences in data taken at different facilities. A study was conducted to determine the extent to which wind tunnel turbulence and acoustic disturbances may be responsible for differences in test results in low Reynolds number flows. Results showed that increases in turbulence can substantially reduce the well known low Reynolds number stall hysteresis effect and can even eliminate the hysteresis loop. Acoustic disturbances of the proper frequency and level can produce similar effects and may produce even more substantial alteration of test results than turbulence. Users of low Reynolds number aerodynamic data and designers of aircraft for this flight regime should be sure that the data they use has not been prejudiced by the turbulence and noise effects found in this research. Author

A86-19753#
UNSTEADY THREE-DIMENSIONAL SIMULATIONS OF A VTOL UPWASH FOUNTAIN
R. E. CHILDS and D. NIXON (Nielsen Engineering and Research, Inc., Mountain View, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(Contract F49620-85-C-0055)
(AIAA PAPER 86-0212)

Numerical simulations of a planar turbulent wall jet and a planar VTOL upwash fountain have been performed. These are three-dimensional simulations which resolve large scale unsteady motions in the flows. The wall jet simulation shows good agreement with experimental data and is presented to verify the simulation methodology. Simulation of the upwash fountain predicts elevated shear stress and a half-velocity width spreading rate of 33 percent which agrees well with experiment. Turbulence mechanisms which contribute to the enhanced spreading rate are examined. Author

A86-19774#
SPANWISE TURBULENCE EFFECTS ON AIRCRAFT RESPONSE
E. A. RINGNES, D. W. CAMP, and W. FROST (FWG Associates, Inc., Tullahoma, TN) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 5 p.
(AIAA PAPER 86-0255)

Turbulence across the span of a wing influences the dynamic response of an aircraft. In this paper, flight data conlected with the NASA B-57B research aircraft as part of the Gust Gradient Program is utilized to investigate spanwise turbulence. The theoretical modeling is set up to calculate the aerodynamic moments and forces developed due to a distribution of turbulence. This is made possible by the three independent records of both angle of attack and airspeed from the aircraft nose and each wing tip. The magnitude of these moments and forces, called the effects of spanwise turbulence, are presented. Furthermore, as a second part of the study, the spanwise turbulence effects are incorporated into a six-degrees-of-freedom flight simulation carried out on a Pixel computer. The results from the simulation show significant influences from spanwise turbulence effects. As expected, the roll mode of the B-57B dynamic response is most strongly excited. Author

A86-19789#
NUMERICAL SIMULATION OF IMPINGING JETS
M. H. RIZK and S. MENON (Flow Research Co., Kent, WA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 15 p. refs
(Contract F49620-84-C-0027)
(AIAA PAPER 86-0279)

Direct numerical simulation using both the three-dimensional and two-dimensional, time-dependent Navier-Stokes equations is used to investigate V/STOL jet-induced interactions. The objective of this numerical simulation is to compute accurately the details of the flow field and to achieve a better understanding of the physics of the flow, including the role of initial turbulence in the jet, the influence of forward motion on hover aerodynamics, and the characteristics of the collision zone and the fountain. Preliminary results are presented. Author

A86-19807*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DESIGN OF A NATURAL LAMINAR FLOW WING FOR A TRANSONIC CORPORATE TRANSPORT
R. L. CAMPBELL, E. G. WAGGONER, and P. S. PHILLIPS (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0314)

Two- and three-dimensional computational methods were used to design a wing for a transonic corporate transport that had significant runs of laminar flow on both upper and lower wing surfaces at the cruise condition. The airfoil was derived from a low-speed laminar-flow section. The contour was systematically modified based on results from a two-dimensional transonic code to give favorable pressure gradients to 50-percent chord on the upper surface and 65-percent chord on the lower surface. Three-dimensional transonic codes were used to determine the wing twist and to evaluate the aerodynamic characteristics of the complete configuration at various flight conditions. A leading-edge modification for improved stall characteristics was also designed. The theoretical pressure distributions for the final airfoil correlated well with results from wind-tunnel tests. Author

A86-19808*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN EVALUATION OF LEADING-EDGE FLAP PERFORMANCE ON DELTA AND DOUBLE-DELTA WINGS AT SUPERSONIC SPEEDS
P. F. COVELL, D. S. MILLER, and R. M. WOOD (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0315)

The aerodynamic performance of leading-edge flaps on three delta double-delta wing planforms having aspect ratios of 1.75, 2.11, and 2.50, have been investigated experimentally. The wings were mounted on a generic fuselage without an inlet canopy, or a vertical tail. The Mach numbers of the flow over the wings were 1.60, 1.90 and 2.16. A primary set of full-span leading-edge flaps with similar root and tip chords were tested on each wing, and several alternate flap planforms were tested on the aspect ratio 1.75 wings. It is found that all leading edge geometries were effective in reducing drag lifting over the range of wing aspect ratios and Mach numbers tested. Greater flap performance was obtained when primary flaps were applied to the delta planform. In general, the primary flap geometry yielded better performance than the alternative geometries tested. Flow visualization techniques were found to be useful for identifying the beneficial effects of leading-edge flap deflection on flow separation as well as fuselage interference effects. Black and white photographs of the delta and double-delta planforms are provided. I.H.

A86-19809*# Vigyan Research Associates, Inc., Hampton, Va.
SHAPING OF AIRPLANE FUSELAGES FOR MINIMUM DRAG
S. S. DODBELE, C. P. VAN DAM (Vigyan Research Associates, Inc., Hampton, VA), B. J. HOLMES (NASA, Langley Research Center, Hampton, VA), and P. M. H. W. VIJGEN AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 13 p. refs
(Contract NAG1-345; NAS1-17926)
(AIAA PAPER 86-0316)

The VSAERO surface panel method is employed to investigate fuselage shapes which can enhance the natural laminar flow (NLF) characteristics. The study is performed at cruise Re which are relevant to commuter, transport, and business aircraft. The technique is based on piecewise constant doublet and source singularities and takes into account the effects of compressibility. Inviscid pressure distributions were generated for five configurations to aid in the search for an optimized NLF body shape as a function of the transition locations and the drag coefficients. Granville's transition criteria are incorporated into the calculations to yield shapes with longer runs of laminar flow and reduced drag. In comparison with other transition prediction methods, the method described is shown to have significantly higher valicity for making three-dimensional transition predictions. M.S.K.

A86-19810*# Missouri Univ., Rolla.
INVESTIGATION OF CHORD RATIO, STAGGER, DECALAGE ANGLE, AND FLAP ANGLE FOR DUAL WING CONFIGURATIONS
B. P. SELBERG (Missouri-Rolla, University, Rolla) and G. D. VINCENT AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(Contract NAG1-26)
(AIAA PAPER 86-0317)

Aerodynamical closely coupled dual wing configurations of unequal chords are investigated for medium speed general aviation applications. Vortex panel and momentum boundary layer analysis are utilized for the two-dimensional predictions. A multi-surface vortex lattice method is used for the three-dimensional predictions. In the process of searching for the highest lift to drag ratio upper airfoil to lower airfoil chord ratios, both greater than and less than one, are investigated in terms of stagger, decalage angle, and gap. With the optimum chord ratio, at the optimum stagger and gap, proper spanwise decalage distribution is shown to yield the lowest two dimensional drag results. Various wing taper ratios and wing twists are investigated to increase wing efficiency. Comparisons are made between optimized dual and optimized single wing configurations both with the same fuselage, stabilator surfaces, engines, payload, and fuel. The dual wing configuration is shown to have significantly less drag and hence longer range than the conventional single wing configuration. Author

A86-19817*# Notre Dame Univ., Ind.
VISUALIZATION AND FLOW SURVEYS OF THE LEADING EDGE VORTEX STRUCTURE ON DELTA WING PLANFORMS
F. M. PAYNE, T. T. NG, R. C. NELSON (Notre Dame, University, IN), and L. B. SCHIFF (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 13 p. Research supported by the University of Notre Dame. refs
(Contract NAG2-258)
(AIAA PAPER 86-0330)

In the present experimental investigation of thin delta wing vortex breakdown, for the cases of sweep angles of 70, 75, 80, and 85 deg, and smoke flow visualization/laser light sheet technique is used to obtain cross sectional views of the leading edge vortices as they break down. A combination of lateral and longitudinal cross sectional views furnishes data on the three-dimensional character of the vortex before, during, and after breakdown. Velocity measurements conducted with a laser Doppler anemometer on the 70 deg sweep delta, at 30 deg angle-of-attack, indicate that when breakdown occurs the core flow is transformed from a jet-like to a wake-like flow. O.C.

A86-19833#
VORTEX-AIRFOIL INTERACTION TESTS
D. D. SEATH and D. R. WILSON (Texas, University, Arlington) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 5 p.
(Contract DAAG29-84-K-0131)
(AIAA PAPER 86-0354)

Low-speed wind tunnel tests were conducted of a pressure-tapped wing model that spanned the test section and was located downstream of a half-wing model that generated a tip vortex. Tests of this perpendicular vortex-airfoil interaction showed that the vortex caused a substantial change in the pressure distribution of the downstream wing and also exhibited a spanwise drift as it passed over the wing. The spanwise drift was in the same direction as the spanwise component of the induced flow at the wing surface, and may be attributed to an image effect, similar to the drifting apart of a wing's trailing vortices as they approach the ground. Author

A86-19855#
EVALUATION OF METHODS FOR PREDICTING COMPLEX AIRCRAFT FLOWFIELDS
A. CENKO (Hofstra University, Hempstead, NY) and F. TESSITORE (Grumman Aerospace Corp., Bethpage, NY) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0396)

Reliable methods for predicting external aircraft flowfields are required for airframe/inlet and aircraft/store integrations, as well as for predicting store trajectories. Several analytic techniques exist which, under certain conditions, can predict the flowfield of complex aircraft configurations. This paper evaluates three of these - the PAN AIR panel method, the Boppe Transonic small disturbance code, and the Grumman TFM technique - and compares them to each other as well as to experimental data and other codes. Author

A86-19870#
THREE-DIMENSIONAL BODY-FITTING GRID SYSTEM FOR A COMPLETE AIRCRAFT
S. J. SCHERR and J. S. SHANG (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0428)

A three-dimensional body-fitted grid system is generated for use in solving the Reynolds-averaged Navier-Stokes equations of the flow field about a complete aircraft. A single-block

multiple-plane mesh is constructed by juxtaposition of two-dimensional cross-sections. A composite grid is used to ensure that the mesh is boundary conformal and orthogonal at the vehicle surface. The mesh singularity inherent in a body-conformal system at the nose of the vehicle is removed by use of analytic continuation and reflection properties. Author

A86-19871*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THREE-DIMENSIONAL ELLIPTIC GRID GENERATION ABOUT FIGHTER AIRCRAFT FOR ZONAL FINITE-DIFFERENCE COMPUTATIONS
R. L. SORENSON (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 8 p. refs
(AIAA PAPER 86-0429)

An elliptic grid-generation method for finite-difference computations about complex aerodynamic configurations is developed. A zonal approach is used, which involves first making a coarse global grid filling the entire physical domain and then subdividing regions of that grid to make the individual zone grids. The details of the grid-generation method are presented along with results of the present application, a wing-body configuration based on the F-16 fighter aircraft. Author

A86-19873*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DEFINITION AND VERIFICATION OF A COMPLEX AIRCRAFT FOR AERODYNAMIC CALCULATIONS
T. A. EDWARDS (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0431)

Techniques are reviewed which are of value in CAD/CAM CFD studies of the geometries of new fighter aircraft. In order to refine the computations of the flows to take advantage of the computing power available from supercomputers, it is often necessary to interpolate the geometry of the mesh selected for the numerical analysis of the aircraft shape. Interpolating the geometry permits a higher level of detail in calculations of the flow past specific regions of a design. A microprocessor-based mathematics engine is described for fast image manipulation and rotation to verify that the interpolated geometry will correspond to the design geometry in order to ensure that the flow calculations will remain valid through the interpolation. Applications of the image manipulation system to verify geometrical representations with wire-frame and shaded-surface images are described. M.S.K.

A86-19880*# Massachusetts Inst. of Tech., Cambridge.
COMPARISON OF COMPUTATIONS AND EXPERIMENTAL DATA FOR LEADING EDGE VORTICES - EFFECTS OF YAW AND VORTEX FLAPS
E. M. MURMAN, K. G. POWELL (MIT, Cambridge, MA), D. S. MILLER, and R. M. WOOD (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p. refs
(Contract NAG1-358)
(AIAA PAPER 86-0439)

Computations are presented using the conical Euler equations for swept delta wings with leading edge vortices. All the wings have sharp leading edges swept at 75 degrees to the freestream. In addition to an idealized flat plate model, geometrical features also included are thickness, centerbody, and two vortex flaps. Freestream Mach numbers of 1.7 to 2.8, angles of attack of 10 and 12 degrees, and angles of yaw of 0 and 8 degrees are considered. The computations are compared with pitot pressure traverses for one case. Other calculations are compared with pitot pressure traverses for one case. Other calculations are compared with surface pressure data and vapor screen pictures recently obtained at NASA Langley Research Center. The comparisons indicate that the dominant features of these flows are adequately modeled by the Euler equations, but viscous models are needed for the surface boundary layer and secondary separations. Author

A86-19892#
A NUMERICAL SOLUTION OF THE DOWNWASH ASSOCIATED WITH A BLOWN-FLAP SYSTEM
E. LOTH and B. W. MCCORMICK (Pennsylvania State University, University Park) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. refs
(Contract N62269-84-C-0437)
(AIAA PAPER 86-0473)

For blown flap aircraft, large downwashes typically occur downstream of the wing due to the high downward momentum of the lifting jet. To determine the velocities induced by the wing and jet flap circulation, a 3-D nonlinear finite element model has been developed which can predict downwash angles at any desired location. Vortex lattices positioned on the wing, flap, and thin jet sheet provide vortex filaments and control points to satisfy kinematic and dynamic boundary conditions. To simplify the mixed-boundary value problem and to reduce computer run time, the roll up of the wake in the spanwise direction has been neglected. In addition, the spanwise distribution of circulation in the wake is assumed to be elliptic in form, a reasonably fast and stable iterative method was used which allowed a self-consistent wake path to be found. Predicted downwash and lift coefficients generally agree with experimental values for various test conditions, but further improvements such as fuselage modeling would enhance the accuracy of the model. Author

A86-19893*# Nielsen Engineering and Research, Inc., Mountain View, Calif.
LIFT AUGMENTATION VIA SPANWISE TIP BLOWING - A NUMERICAL STUDY
R. E. CHILDS (Nielsen Engineering and Research, Inc., Mountain View, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. NASA-supported research.
(Contract F33615-83-C-3033)
(AIAA PAPER 86-0474)

Numerical simulations of a low aspect ratio wing with and without a spanwise directed jet issuing from the wing tip have been performed. The results show that the tip vortex is displaced outward and upward by the blowing. This gives rise to a local lift augmentation mechanism, vortex lift caused by the vortex core being above the wing, and a global mechanism, the reduction of induced velocities due to greater apparent spin. Author

A86-19897*# Ohio State Univ., Columbus.
AERODYNAMIC MEASUREMENTS OF AN AIRFOIL WITH SIMULATED GLAZE ICE
M. B. BRAGG and W. J. COIRIER (Ohio State University, Columbus) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p. NASA-supported research. refs
(AIAA PAPER 86-0484)

An experimental study has been conducted in the OSU subsonic tunnel to measure the detailed aerodynamic characteristics of an airfoil with simulated glaze ice. A special model was built with interchangeable leading edges to be used in this study. One leading edge is that of a NACA 0012, while the other is a simulation of a glaze ice accretion measured in the NACA Lewis Icing Research Tunnel. The model was instrumented with a dense distribution of surface pressure taps to provide excellent detail around the ice shapes and reattachment point. A traversing total pressure probe was used to document the boundary layer characteristics on the NACA 0012 section. The ice shape caused a severe lift and drag penalty, reducing the maximum lift by over 50 percent and causing a 300 percent increase in drag. Surface pressure distributions revealed a large lower surface separation in addition to the expected large upper surface separation. Author

A86-19908#
CONFORMAL MAPPING AS AN AID IN GRID GENERATION FOR COMPLEX THREE-DIMENSIONAL CONFIGURATIONS
N. D. HALSEY (Douglas Aircraft Co., Long Beach, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. Research sponsored by the McDonnell Douglas Independent Research and Development Program. refs
(AIAA PAPER 86-0497)

Conformal mapping is a very useful, but under-exploited, tool in the construction of body-fitted finite-difference (or finite-volume) grids for complex three-dimensional configurations. It has been used frequently for many two-dimensional problems and, to a lesser extent, for simple three-dimensional configurations, such as isolated wings or nacelles and wing/body combinations. This paper describes applications of conformal mapping in generating grids about three-dimensional nacelles with and without other aircraft components in close proximity. In the most complicated case considered, a grid is generated about an aft-fuselage-mounted nacelle/pylon configuration. Author

A86-19922#
PRACTICAL APPLICATIONS OF NEW LU-ADI SCHEME FOR THE THREE-DIMENSIONAL NAVIER-STOKES COMPUTATION OF TRANSONIC VISCOUS FLOWS
K. FUJII (National Aerospace Laboratory, Chofu, Japan) and S. OBAYASHI (Tokyo, University, Japan) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p. refs
(AIAA PAPER 86-0513)

The new LU-ADI factorization algorithm for the three-dimensional Navier-Stokes computations is developed by using the diagonally dominant LU factorization. The applications are done for a practical wing shape designed for transonic transport aircraft. Computations are carried out for several angle-of-attack cases, including the design point and the buffet limit. The computed surface pressure distributions agree with the experiment, in spite of the complicated wing geometry. The C(L)-alpha curve is plotted, with good agreement with the experiment. The computation for each case takes only about an hour and a half with the aid of a supercomputer. The preliminary computation is done for the wing-body combination, and the result is quite reasonable and promising. These results indicate the possibility of the three-dimensional Navier-Stokes code for the flow field simulations over an entire aircraft configuration. Author

A86-19949*# Scientific Research Associates, Inc., Glastonbury, Conn.
A THREE-DIMENSIONAL VISCOUS FLOW ANALYSIS FOR THE HELICOPTER TIP VORTEX GENERATION PROCESS ABOUT SQUARE AND ROUND TIPPED BLADES
S.-J. LIN, R. LEVY, and S. J. SHAMROTH (Scientific Research Associates, Inc., Glastonbury, CT) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 14 p. Previously announced in STAR as N85-34114. refs
(Contract NAS1-14904)
(AIAA PAPER 86-0560)

The tip vortex flow field occurring in the vicinity of the tip region of a helicopter rotor blade is a very complicated three-dimensional, viscous flow phenomenon. The details of the flow in the tip region can have a major effect in determining the generated rotor noise and can significantly effect the performance and dynamic loading of the rotor blade. The three-dimensional viscous subsonic tip vortex generation processes is investigated by a numerical procedure which allows spatial forward-marching integration, utilizing flow approximations from the velocity-decomposition approach of Briley and McDonald. The approach has been applied to compute the laminar and turbulent tip vortex flows for a constant thickness slab airfoil with a square tip, a constant thickness slab airfoil with a half round tip and a NACA 0012 airfoil with a half round tip. The basic mechanism of the tip vortex generation process as well as the prediction of vortex appearance, strength and secondary flow shown by the calculations are in qualitative agreement with experimental results. Author

A86-19951#
VORTEX ROLL-UP FOR AN ELLIPTICALLY-LOADED WING AT MODERATELY LOW REYNOLDS NUMBERS
H. HIGUCHI, J. C. QUADRELLI, and C. FARELL (Minnesota, University, Minneapolis) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(AIAA PAPER 86-0562)

An experimental investigation of tip-vortex roll-up was undertaken at moderately low Reynolds numbers, for an elliptically-loaded foil with a NACA 66(2)-415 section. Flow visualizations and laser Doppler velocimetry measurements were carried out to examine the flow in the vortex core and the tangential velocity distributions around the core. Separation was observed on both sides of the foil for Reynolds numbers up to 500,000. The observed changes in the location of separation and reattachment with angle of attack and Reynolds number, were adequately predicted by laminar boundary layer calculations. Axial and tangential velocity profile measurements were made at Reynolds numbers up to about 50,000. The vortex core radius was found to grow with increasing angle of attack, increasing downstream distance, and decreasing Reynolds number. A comparison of the experimentally determined velocity distributions and core sizes, with the predictions of inviscid, laminar, and turbulent vortex models, is presented. Author

A86-19964#
A PREDICTIVE TECHNIQUE FOR DETERMINING STORE MOTION AFTER RELEASE FROM A CARRIER VEHICLE AT SUPERSONIC SPEEDS
A. J. CULOTTA (Martin Marietta Corp., Orlando, FL) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 13 p. refs
(AIAA PAPER 86-0586)

A new technique has been devised for predicting the motion of a single store released from a supersonic carrier vehicle. The technique involves the simplified determination of store aerodynamics and 3-DOF motion in the carrier vehicle's flow field as modified by expansion fans and shock waves arising from open bays or surface recesses. Determination of these flow field features is assisted through flow visualization by means of low cost water table hydraulic analog. Technique verification was accomplished using M = 2, 3, and 4 grid survey and captive trajectory wind tunnel data and is applicable to both internally and conformally carried stores. Comparisons between computer predictions and experimental normal force and moment coefficients and pitch angle during separation show excellent agreement. For internally carried stores, computational results dramatically illustrate the dependence of store motion on various factors, such as, the carrier vehicle's bay pressure, strength of the carrier vehicle's bow show wave, initial ejection rates and accelerations and store aerodynamics. Technique limitations center around the means by which store aerodynamics are computed in a nonuniform flow field and the ability to define bay pressure during the separation events. This later limitation does not exist for conformally carried stores. Author

A86-19966*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EVALUATION OF AN AERODYNAMIC-LOAD PREDICTION METHOD ON A STOL FIGHTER CONFIGURATION
J. KATZ (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 18 p. Previously announced in STAR as N86-10015. refs
(AIAA PAPER 86-0590)

A three-dimensional panel method was used to compute the aerodynamic loads on a large-scale, powered wind tunnel model. The size of the computation grid was selected such that turnaround times, on present computers remained satisfactory. With this constraint, the STOL aircraft configuration was modeled and the capabilities and limitations of the prediction method were investigated. After this study, a similar numerical model was established for a forward-swept-wing aircraft configuration which is planned for large-scale, low-speed testing. The resulting

aerodynamic-load predictions are discussed and will be utilized, together with the future experimental results, to obtain a broader validation of this method as well as to reduce the necessary size of the matrix of the test parameters. Author

A86-19971*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE CRITICAL ROLE OF COMPUTATIONAL FLUID DYNAMICS IN ROTARY-WING AERODYNAMICS
S. S. DAVIS and I.-C. CHANG (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 25 p. refs
(AIAA PAPER 86-0336)

The field of helicopter rotor aerodynamics is basically the study of unsteady aerodynamic flows in a rotating and translating coordinate system. Current trends in this field are briefly reviewed by examining recent advances in lifting-surface theory, wake modeling, panel methods, and finite-difference models. Examples are used to illustrate selected current methods and some indications of promising future directions are highlighted. Author

A86-20124
AIRCRAFT VISCOUS DRAG REDUCTION TECHNOLOGY
A. S. W. THOMAS (Lockheed-Georgia Co., Marietta, GA) Lockheed Horizons, Oct. 1985, p. 22-32.

An evaluation is made of the performance improvement prospects that accrue to viscous drag reduction in subsonic aircraft through laminar flow control (LFC), with attention to the development status of the requisite technology. Major system types currently under consideration are aerodynamic section tailoring to yield sustained natural laminar flow, the use of active skin suction through small holes to laminarize turbulent boundary layers, skin cooling by cryogenic liquids such as liquid hydrogen fuel, and longitudal, triangular section skin surface microgroovings called 'riblets'. Existing aircraft are noted to be amenable to LFC efficiency improvements through the judicious addition of strakes and winglets that modify vortex flows shed (respectively) by fuselage afterbodies and wings. Novel, low turbulence aircraft configurations for future development are presented. O.C.

A86-20156*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
MODELING AERODYNAMIC RESPONSES TO AIRCRAFT MANEUVERS - A NUMERICAL VALIDATION
J. KATZ and L. B. SCHIFF (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 19-25. Previously cited in issue 20, p. 2847, Accession no. A84-42335. refs

A86-20159*# Lockheed-Georgia Co., Marietta.
NUMERICAL SIMULATION OF THE TRANSONIC FLOWFIELD FOR WING/NACELLE CONFIGURATIONS
E. H. ATTA and J. VADYAK (Lockheed-Georgia Co., Advanced Flight Sciences Dept., Marietta, GA) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 39-46. Research sponsored by the Lockheed Independent Research and Development Program. Previously cited in issue 03, p. 254, Accession no. A85-13964. refs
(Contract NAS2-11285)

A86-20164*# Ohio State Univ., Columbus.
AIRFOIL AERODYNAMICS IN ICING CONDITIONS
M. B. BRAGG, G. M. GREGOREK, and J. D. LEE (Ohio State University, Columbus) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 76-81. NASA-supported research. refs

Methods of analyzing and experimentally measuring the effect of ice accretion on airfoil sections are presented. Empirical and analytical methods for predicting airfoil performance degradation due to ice are discussed. Ice simulation techniques for aerodynamic testing are presented and compared to data with actual ice accretions. The results show that simulation techniques to imitate the effect of ice on airfoil performance work well in most cases. Comparisons between predicted and measured airfoil performance with ice accretions are presented. For rime ice cases, the predictions compared well with experiments; but for glaze ice, a need for improved methods are seen. Author

A86-20939
EULER SOLVERS AS AN ANALYSIS TOOL FOR AIRCRAFT AERODYNAMICS
W. SCHMIDT (Dornier GmbH, Friedrichshafen, West Germany) and A. JAMESON (Princeton University, NJ) IN: Advances in computational transonics . Swansea, Wales, Pineridge Press, 1985, p. 371-404. refs

The present chapter is concerned with numerical techniques for solving hyperbolic systems of partial differential equations, taking into account the solution of the Euler equations. It is pointed out, however, that the presented algorithms have been successfully applied also to the Navier Stokes equations. The governing set of differential equations is discussed, giving attention to time-dependent Euler equations, transformed equations, the finite volume approach, and relations at discontinuities. Aspects of numerical discretization are also explored. Central space approximations are considered along with dissipative terms, time stepping schemes, boundary conditions, and Kutta conditions for lifting flows. Other topics studied are related to convergence acceleration, two-dimensional flows, and three-dimensional flows. G.R.

A86-20946* California Univ., Los Angeles.
SHOCK MODELLING IN TRANSONIC AND SUPERSONIC FLOW
S. OSHER (California, University, Los Angeles) IN: Advances in computational transonics . Swansea, Wales, Pineridge Press, 1985, p. 607-643. refs
(Contract NSF MCS-82-00788; DAAG29-82-K-0090; NAG1-270; NAG1-273)

Numerical simulation studies of problems in transonic flow are conducted in connection with the design of aircraft flying near the speed of sound, while recently there has also been a great deal of interest in supersonic and hypersonic flow calculations. Three important models for inviscid compressible gasdynamics are utilized in the study of these flow problems, taking into account the transonic small disturbance equation (TSD), the transonic full potential equation (FP), and the full Euler equations for compressible gasdynamics (EU). The present paper has the objective to provide a description of shock capturing methods recently developed for each model. The design principles behind the algorithms are also examined, giving attention to consistency, conservative form, monotone and sharp discrete shocks, and a bound on the variation, which prevents spurious oscillations. G.R.

A86-20953* Boeing Military Airplane Development, Seattle, Wash.
A TRANSONIC RECTANGULAR GRID EMBEDDED PANEL METHOD
F. T. JOHNSON, J. E. BUSSOLETTI, A. C. WOO (Boeing Military Airplane Co., Seattle, WA), and D. P. YOUNG (Boeing Computer Services Co., Tukwila, WA) IN: Advances in computational transonics . Swansea, Wales, Pineridge Press, 1985, p. 835-874. refs
(Contract NAS2-9830)

In this chapter, a description is given of a nonstandard method which has the ultimate goal to provide a routine solution of transonic flow problems about large, complex configurations. For a number of reasons, it is difficult to extend standard methods to the solution of flows about complicated configurations. According to the particular approach of the considered nonstandard method, in the process of solving for linear potential flow via panel methods, a flow everwhere in space is created, taking into account the interior of the aircraft as well as the external flowfield of interest. Attention is given to the solution of flow problems without interior boundaries, the treatment of interior boundaries, and areas of current and future research. G.R.

A86-21033
THE NUMERICAL SOLUTION OF THE COMPRESSIBLE VISCOUS FLOW FIELD ABOUT A COMPLETE AIRCRAFT IN FLIGHT
R. W. MACCORMACK (Washington, University, Seattle) IN: Computational methods in viscous flows . Swansea, Wales, Pineridge Press, 1984, p. 225-254. refs
(Contract AF-AFOSR-83-0057)

Estimates made by Chapman (1979) of the number of mesh points and computer memory required to calculate the viscous flow field about a complete aircraft at flight Reynolds number are reviewed, and it is noted that the required computer capability will become available in the near future. The problems associated with the fitting of a mesh around an aircraft and the numerical procedures required for such a flow calculation are examined. It is argued that the Reynolds-averaged Navier-Stokes equations can be solved about a complete aircraft at cruise conditions with the coming computer resources with the same degree of accuracy and cost as present high Reynolds number calculations for flow past relatively simple aerodynamic shapes. V.L.

A86-21345
A SOLUTION TO THE PROBLEM OF FLOW PAST WINGS WITH ALLOWANCE FOR FLOW SEPARATION ON THE BASIS OF A SYSTEM OF EULER EQUATIONS [RESHENIE ZADACHI OBTEKANIIA KRYL'EV S UCHETOM OTRYVA POTOKA NA OSNOVE SISTEMY URAVNENIIA EILERA]
A. P. SHASHKIN (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskie Nauki (ISSN 0002-3434), Oct. 1985, p. 34-40. In Russian. refs

The problem of supersonic flow of a gas past wings is analyzed with allowance for possible flow separation using complete Euler equations. A numerical implementation of such a flow is presented for delta wings with subsonic edges. The results obtained are verified experimentally. V.L.

A86-22057#
TRANSONIC BLADE TO BLADE CALCULATIONS IN AN AXIAL, RADIAL OR MIXED FLOW CASCADE EQUIPPED WITH SPLITTER BLADES
F. BERTHEAU (DRET, Paris, France), Y. RIBAUD (ONERA, Chatillon-sous-Bagneux and Palaiseau, France), and V. MILLOUR (ONERA, Chatillon-sous-Bagneux, France) ASME, International Gas Turbine Conferences and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 7 p. DRET-supported research. refs
(ASME PAPER 85-GT-86; ONERA, TP NO. 1985-23)

A general computer code for pseudo-unsteady Euler equations integration in turbomachinery cascades has been developed. A quasi-three-dimensional flow hypothesis is assumed and only blade to blade calculation is considered here. Cascades may be axial, radial or mixed flow type. First the computerized quasi-orthogonal network is shown. This network takes into account splitters and is designed to reduce the computation time. Then, the numerical method is described and the major difficulties of this problem, which are boundary conditions, leading edge and trailing edge treatments, are presented. Finally, examples of calculations on turbines and compressors are given with emphasis on graphic representation. Author

A86-22115#
PRODUCTION AND DEVELOPMENT OF SECONDARY FLOWS AND LOSSES WITHIN A THREE DIMENSIONAL TURBINE STATOR CASCADE
A. YAMAMOTO and R. YANAGI (National Aerospace Laboratory, Chofu, Japan) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 9 p. Research supported by the Ministry of International Trade and Industry. refs
(ASME PAPER 85-GT-217)

Using five-hole pitot tubes, detailed flow measurements were made before, within and after a low-speed three-dimensional turbine stator blade row to obtain quantitative information on the aerodynamic loss mechanism. Qualitative flow visualization tests and endwall static pressure measurements were also made. An analysis of the tests revealed that many vortical flows promote loss generation. Within a large part of the cascade, a major loss process could be explained simply as the migration of boundary layer low energy fluids from surrounding walls (endwalls and blade surfaces) to the blade suction surface near the trailing edge. On the other hand, complexity exists after the cascade and in the vortical flows near the trailing edge. The strong trailing shedding vortices affect upstream flow fields within the cascade. Detailed flow surveys within the cascade under the effects of blade tip leakage flows are also included. Author

A86-22117#
AN ELEVEN PARAMETER AXIAL TURBINE AIRFOIL GEOMETRY MODEL
L. J. PRITCHARD (Williams International, Walled Lake, MI) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 12 p. refs
(ASME PAPER 85-GT-219)

The mathematical derivation, and FORTRAN code, of a comprehensive but easy to use geometry model for axial flow turbine nozzles and rotors is presented. To uniquely define an airfoil on a cylinder the aerodynamicist need only specify the number of blades, and at each radius of interest: the axial and tangential chord, throat, uncovered turning, leading and trailing edge radii, inlet and exit blade angles, and inlet wedge angle. Default values exist for six of these geometric variables, which proves useful when starting a design. Both the suction and the pressure surfaces are described entirely by analytical functions. Sample airfoils are included that demonstrate the effect of each parameter upon blade shape. Author

A86-22303#
CALCULATION OF EXTERNAL AND INTERNAL TRANSONIC FLOW FIELD OF A THREE-DIMENSIONAL SHIELDED S-SHAPED INLET
H. SHEN, S. LUO, M. JI, Z. XING, X. ZHU et al. Northwestern Polytechnical University, Journal, vol. 3, Oct. 1985, p. 447-458. In Chinese, with abstract in English. refs

Internal and external three-dimensional transonic flow fields of shield s-shaped inlets are calculated, including the forebody, at different angles of attack and yaw angles. An improved analytical continuation method is developed to treat the boundary condition at the solid surface. When the geometry of objects is complex, the whole computation region is divided into three parts and different physical coordinate systems are applied to each part. Data for the interfaces of neighboring parts are transferred using interpolation formulas, and good convergence and calculational stability are achieved. Sample computations of two s-shaped inlets are performed using the present method, and the results are compared with those obtained by the perturbation method and with experimental results. The comparison indicates that the present method is promising. C.D.

A86-22311#
A VORTEX LATTICE METHOD FOR JET WING PERFORMANCE WITH NONLINEAR WAKE AND TIP FLOW
Z. CHEN (Beijing Institute of Aerodynamics, People's Republic of China) and J. M. WU (Tennessee, University, Tullahoma) Acta Aeronautica et Astronautica Sinica, vol. 6, Aug. 1985, p. 329-334. In Chinese, with abstract in English. refs

A three-dimensional nonlinear method for determining the aerodynamic performance of a jet flap wing has been developed. The method utilizes a system of bound and free vortices with vortex lattices to represent the wing, jet wake, and tip vortices. This method satisfies both kinematic and dynamic conditions, and takes vortex interaction into consideration. The solutions obtained include chordwise and spanwise load distributions, from which sectional and total aerodynamic qwantities are derived. The jet-wake sheet and the tip vortex shape are determined simultaneously, taking nonlinear effects into account. The solutions agree with other analytical results and available data for a jet

wing with large aspect ratio. The method is applicable to cases with large jet blowing angles as well. C.D.

A86-22319#
CALCULATION OF SUPERSONIC FLOWS AROUND A THREE-DIMENSIONAL WING AND A WAISTED BODY WITH CHARACTERISTIC METHOD IN STREAM SURFACE COORDINATES
B. WANG (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, Aug. 1985, p. 393-396. In Chinese, with abstract in English. refs

A86-22692#
SIMULATION OF DIFFUSER DUCT FLOWFIELDS USING A THREE-DIMENSIONAL EULER/NAVIER-STOKES ALGORITHM
J. VADYAK (Lockheed-Georgia Co., Marietta, GA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 15 p. Research sponsored by the Lockheed Independent Research and Development Program. refs
(AIAA PAPER 86-0310)

An analysis is presented for calculating steady (or unsteady) three-dimensional aircraft diffuser duct (or thrust nozzle) flowfields. This algorithm can compute the flowfield in axisymmetric or arbitrary asymmetric diffuser duct configurations at subsonic, transonic, or supersonic speeds. The algorithm can solve either the Euler momentum equations for inviscid flow, the thin-shear-layer Navier-Stokes equations for viscous flow, or the full Navier-Stokes equations for viscous flow. The flowfield is determined on a body-fitted numerically-generated computational grid. A fully-implicit alternating-direction-implicit algorithm is employed for solution of the finite-difference equations. Numerical results and correlations with experiment are presented to illustrate application of the analysis. Author

A86-22693*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
VELOCITY AND TEMPERATURE DECAY CHARACTERISTICS OF INVERTED-PROFILE JETS
U. VON GLAHN, J. GOODYKOONTZ, and C. WASSERBAUER (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 31 p. Previously announced in STAR as N86-14223. refs
(AIAA PAPER 86-0312)

In order to design efficient, lightweight flap systems for future engine under-the-wing STOL aircraft, the velocity and temperature decay rate of the jet plume must be increased relative to that for single-stream nozzles in order to provide local flap loads and structural temperatures within acceptable limits. The jet plume decay rate of dual flow engines can be increased by resorting to inverted-profile velocity and temperature nozzle concepts. The peak axial decay characteristics of model-scale, two-stream inverted-profile nozzle flows are empirically correlated. Also discussed are the radial and spreading characteristics of inverted-profile nozzle flows. Author

A86-22701#
NUMERICAL ISSUES IN COMPUTING INVISCID SUPERSONIC FLOW OVER CONICAL DELTA WINGS
S. R. CHAKRAVARTHY and D. K. OTA (Rockwell International Science Center, Thousand Oaks, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 20 p. refs
(AIAA PAPER 86-0440)

For a thin elliptic cone with half angles 20 degrees and 1.5 degrees, recent numerical results obtained with various methods based on central difference approximations show a distinct difference between solutions obtained on 'fine' and 'coarse' grids. The study reported in this paper began by using methods based on state-of-the-art high-resolution upwind-biased Total Variation Diminishing (TVD) formulations to study the same problem. These techniques resulted in consistent solutions on 'fine', 'coarse', and 'very coarse' grids. A systematic study of the differences between methods based on central and upwind discretizations was then initiated to see if they contributed to the distinct types of solutions obtained with them. After an extensive study, a surprising conclusion emerged: the anomalous behavior of the solutions obtained using central difference approximations need not be due to any fundamental difference between these and upwind schemes, but can be purely a result of using spatially varying time steps. In fact, it is shown in this paper, that such solutions can be obtained with upwind-biased approximations also by using spatially varying time steps. Author

A86-22702#
INFLUENCE OF WING TIP CONFIGURATION ON LATERAL BLOWING EFFICIENCY
D. TAVELLA, C. S. LEE, and N. J. WOOD (Stanford University, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 5 p. refs
(AIAA PAPER 86-0475)

An experimental investigation of the effect of slot position and orientation on the aerodynamic characteristics of the lateral wing tip blowing concept was conducted. It was found that displacing the slot closer to the upper surface of the wing enhances the lift augmentation. The same happens when the slot is slanted downward. The first effect is primarily viscous, while the second appears to have also an inviscid character. Both effects manifest themselves as distributed increments of lift along the wing span, above the lift augmentation that would be produced by a symmetrically located slot. It is concluded that the offset slot affects the wing aerodynamics through changes in the jet extension into the free stream, rather than through suction forces due to differential entrainment by the two sides of the jet. The effect of jet slant is in qualitative agreement with theoretical predictions. Author

A86-22704*# Informatics General Corp., Palo Alto, Calif.
NUMERICAL SIMULATION OF TRANSONIC SEPARATED FLOWS OVER LOW-ASPECT RATIO WINGS
U. KAYNAK (Informatics General Corp., Palo Alto, CA), T. L. HOLST, R. L. SORENSON (NASA, Ames Research Center, Moffett Field, CA), and B. J. CANTWELL (Stanford University, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 15 p. refs
(Contract NCA2-OR-745-309)
(AIAA PAPER 86-0508)

Transonic flow fields about a low-aspect-ratio advanced technology wing have been computed using a viscous/inviscid zonal approach. The flow field near the wing where viscous effects are important was solved using the 'Reynolds-Averaged Navier-Stokes Equations' in 'thin-layer' form. The Euler equations were used to determine the flow field in regions away from the wing where viscous effects are insignificant. A zonal grid using an H-H topology was generated around the wing by first solving a set of Poisson's equations for the global grid. This grid was then subdivided into separate zones of viscous or inviscid flow as suggested by the flow physics. A series of flow cases were computed and compared with corresponding sets of experimental data. All cases showed good agreement with experiment in terms of the pressure field. Also, a good correlation between computed separated surface flow and experimental oil flow was obtained. Author

N86-16191# Aeronautical Research Labs., Melbourne (Australia).
A FORTRAN PROGRAM FOR THE DETERMINATION OF UNSTEADY AIRFORCES ON GENERAL COMBINATIONS OF INTERFERING LIFTING SURFACES OSCILLATING IN SUBSONIC FLOW
W. WALDMAN 1985 92 p refs
(ARL-STRUCT-R-412; AR-003-987) Avail: NTIS HC A05/MF A01

The aeroelastic stability of an aircraft is an important consideration in the overall process of determining its airworthiness. When external bodies or stores are added to the wing of an aircraft, the dynamic characteristics of the aircraft will be changed.

Due to the inertial, elastic and aerodynamic coupling between the wing and its stores the flutter speed of the aircraft may be adversely affected. The aerodynamic coupling may be particularly important if the stores have aerodynamic surfaces, such as fins, that can generate large oscillatory aerodynamic forces. There are a number of computer programs which predict unsteady aerodynamic forces acting on oscillating lifting surfaces. These programs, which are based on the doublet lattice method of Albano and Rodden were optimized for simple interfering wing-tail-fin and control surface cases. They are not applicable to general combinations of interfering lifting surfaces. Thus a requirement exists for a computer program that can calculate unsteady aerodynamic forces for general configurations of interfering lifting surfaces, including a capability for dealing with store aerodynamics. Since the doublet lattice method is readily applicable to interfering and nonplanar lifting surfaces, it is used as the basis of a program capable of dealing with general configurations. The doublet lattice method is versatile and there are essentially no restrictions on the configurations that can be handled as long as an appropriate idealization can be developed. G.L.C.

N86-16193*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AERODYNAMIC CHARACTERISTICS OF A HIGH-WING TRANSPORT CONFIGURATION WITH A OVER-THE-WING NACELLE-PYLON ARRANGEMENT

W. P. HENDERSON and W. K. ABEYOUNIS Dec. 1985 93 p refs

(NASA-TP-2497; L-15959; NAS 1.60:2497) Avail: NTIS HC A05/MF A01 CSCL 01A

An investigation has been conducted in the Langley 16-Foot Transonic Tunnel to determine the effects on the aerodynamic characteristics of a high-wing transport configuration of installing an over-the-wing nacelle-pylon arrangement. The tests are conducted at Mach numbers from 0.70 to 0.82 and at angles of attack from -2 deg to 4 deg. The configurational variables under study include symmetrical and contoured nacelles and pylons, pylon size, and wing leading-edge extensions. The symmetrical nacelles and pylons reduce the lift coefficient, increase the drag coefficient, and cause a nose-up pitching-moment coefficient. The contoured nacelles significantly reduce the interference drag, though it is still excessive. Increasing the pylon size reduces the drag, whereas adding wing leading-edge extension does not affect the aerodynamic characteristics significantly. Author

N86-16194*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

VALIDATION OF VISCOUS AND INVISCID COMPUTATIONAL METHODS FOR TURBOMACHINERY COMPONENTS

L. A. POVINELLI 1986 19 p refs Proposed for presentation at the 31st International Gas Turbine Conference, Dusseldorf, West Germany; sponsored by ASME

(NASA-TM-87193; E-2765; NAS 1.15:87193) Avail: NTIS HC A02/MF A01 CSCL 01A

An assessment of several three-dimensional computer codes used at the NASA Lewis Research Center is presented. Four flow situations are examined, for which both experimental data and computational results are available. The four flows form a basis for the evaluation of the computational procedures. It is concluded that transonic rotor flow at peak efficiency conditions may be calculated with a reasonable degree of accuracy, whereas, off-design conditions are not accurately determined. Duct flows and turbine cascade flows may also be computed with reasonable accuracy whereas radial inflow turbine flow remains a challenging problem. Author

N86-16195*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

A NUMERICAL SIMULATION OF THE INVISCID FLOW THROUGH A COUNTER-ROTATING PROPELLER

M. L. CELESTINA (Sverdrup Technology, Inc., Cleveland, Ohio), R. A. MULAC (Sverdrup Technology, Inc., Cleveland, Ohio), and J. H. ADAMCZYK 1986 23 p refs Proposed for presentation at the 31st International Gas Turbine Conference, Dusseldorf, West Germany, 8-12 Jun. 1986; sponsored by ASME

(NASA-TM-87200; E-2855; NAS 1.15:87200) Avail: NTIS HC A02/MF A01 CSCL 01A

The results of a numerical simulation of the time-averaged inviscid flow field through the blade rows of a multiblade row turboprop configuration are presented. The governing equations are outlined along with a discussion of the solution procedure and coding strategy. Numerical results obtained from a simulation of the flow field through a modern high-speed turboprop will be shown. Author

N86-16196*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

FLOW FIELD SURVEY NEAR THE ROTATIONAL PLANE OF AN ADVANCED DESIGN PROPELLER ON A JETSTAR AIRPLANE

K. R. WALSH 1985 29 p refs

(NASA-TM-86037; H-1226; NAS 1.15:86037) Avail: NTIS HC A03/MF A01 CSCL 01A

An investigation was conducted to obtain upper fuselage surface static pressures and boundary layer velocity profiles below the centerline of an advanced design propeller. This investigation documents the upper fuselage velocity flow field in support of the in-flight acoustic tests conducted on a JetStar airplane. Initial results of the boundary layer survey show evidence of an unusual flow disturbance, which is attributed to the two windshield wiper assemblies on the aircraft. The assemblies were removed, eliminating the disturbances from the flow field. This report presents boundary layer velocity profiles at altitudes of 6096 and 9144 m (20,000 and 30,000 ft) and Mach numbers from 0.6 to 0.8, and it investigated the effects of windshield wiper assemblies on these profiles. Because of the unconventional velocity profiles that were obtained with the assemblies mounted, classical boundary layer parameters, such as momentum and displacement thicknesses, are not presented. The effects of flight test variables (Mach number and angles of attack and sideslip) and an advanced design propeller on boundary layer profiles - with the wiper assemblies mounted and removed - are presented. Author

N86-16197*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

MACH NUMBER AND FLOW-FIELD CALIBRATION AT THE ADVANCED DESIGN PROPELLER LOCATION ON THE JETSTAR AIRPLANE

L. D. WEBB Dec. 1985 21 p refs

(NASA-TM-84923; H-1222; NAS 1.15:84923) Avail: NTIS HC A02/MF A01 CSCL 01A

Advanced design propellers on a JetStar aircraft were tested at NASA Ames Research Center's Dryden Flight Research Facility. A calibration of the flow field at the test location to obtain local Mach number and flow direction was performed. A pitot-static probe and flow direction vane installation was installed and tested at Mach 0.3 to 0.8 and altitudes from 3000 m (10,000 ft) to 9100 m (30,000 ft). Local Mach number and flow direction relationships were obtained and related to their noseboom counterparts. Effects of varying angles of sideslip to + or - 3 deg. were investigated. Author

N86-16199*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PRESSURE DISTRIBUTIONS FROM HIGH REYNOLDS NUMBER TESTS OF A BOEING BAC 1 AIRFOIL IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL
W. G. JOHNSON, JR. and A. S. HILL Dec. 1985 271 p refs (NASA-TM-87600; L-16010; NAS 1.15:87600) Avail: NTIS HC A12/MF A01 CSCL 01A

A wind-tunnel investigation designed to test a Boeing advanced-technology airfoil from low to flight-equivalent Reynolds numbers has been completed in the Langley 0.3-Meter Transonic Cryogenic Tunnel. This investigation represents the first in a series of NASA/U.S. industry two-dimensional airfoil studies to be completed in the Advanced Technology Airfoil Test program. Test temperature was varied from ambient to about 100 K at pressures ranging from about 1.2 to 6.0 atm. Mach number was varied from about 0.40 to 0.80. These variables provided a Reynolds number (based on airfoil chord) range from 4.4 X 10 to the 6th power to 50.0 X 10 to the 6th power. All the test objectives were met. The pressure data are presented without analysis in plotted and tabulated formats for use in conjunction with the aerodynamic coefficient data published as NASA TM-81922. At the time of the test, these pressure data were considered proprietary and have only recently been made available by Boeing for general release. Data are included which demonstrate the effects of fixed transition. Also included are remarks on the model design, the model structural integrity, and the overall test experience. Author

N86-16200# Sandia National Labs., Albuquerque, N. Mex.
SIX DEGREE OF FREEDOM SIMULATION OF FLUID PAYLOAD PROJECTILES USING NUMERICALLY COMPUTED FLUID MOMENTS
H. R. VAUGHN, W. P. WOLF, and W. L. OBERKAMPF Jul. 1985 102 p
(Contract DE-AC04-76DP-00789)
(DE85-017183; SAND-85-1166) Avail: NTIS HC A06/MF A01

A flight trajectory simulation method has been developed for calculating a six degree of freedom motion of fluid filled projectiles. Numerically calculated internal fluid moments and experimentally known aerodynamic forces and moments are coupled to the projectile motion. Comparisons of predicted results with flight test data of an M483 155mm artillery projectile with a highly viscous payload confirm the accuracy of the simulation. This simulation clearly shows that the flight instability is due to the growth of the nutation component of angular motion caused by the viscous effects of the fluid payload. This simulation procedure, when used in conjunction with the previously developed method for calculating internal fluid moments, allows the designer to examine the effects of various liquid payloads and container geometries on the dynamic behavior of flight vehicles. DOE

N86-16202# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
IMPLICIT FINITE-DIFFERENCE METHODS FOR THE CALCULATION OF UNSTEADY TRANSONIC POTENTIAL FLOW AROUND TWO-DIMENSIONAL AIRFOILS: A DISCUSSION
J. VANDERVOOREN and H. SCHIPPERS 23 Sep. 1985 33 p refs Submitted for publication
(NLR-MP-83063-U; B8566372) Avail: NTIS HC A03/MF A01

Mathematical modeling of unsteady transonic flow is discussed. Starting from the Euler equations, potential theory is derived and applied to the flow about a 2D airfoil. Motions considered include rigid body motions and deformations of the airfoil. The full-potential equation is formulated on curvilinear coordinates maintaining strong conservation form. Boundary conditions on the airfoil, wake conditions and radiation type far-field conditions are assessed. A numerical method based on time-linearization of the differential equation up to second order accuracy is presented. The resulting equation can be integrated numerically by an implicit locally one-dimensional split method. Approximation of spatial derivatives by fully conservative finite difference schemes employing mass-flux splitting for the capture of shocks is treated. Results for the steady flow about an airfoil illustrate that an Engquist-Osher type scheme at the sonic line is a prerequisite to rigorously suppress nonphysical expansion shocks. Author (ESA)

N86-16203# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
AN EXPERIMENTAL INVESTIGATION OF THE ENTRAINMENT INTO A LEADING-EDGE VORTEX
N. G. VERHAAGEN and L. VANDERSNOEK 1984 60 p refs (VTH-LR-332) Avail: NTIS HC A04/MF A01

The theoretical distribution of the velocity inside the rotational core of a leading-edge is derived using Stewartson and Hall's (1963) outer solution for the rotational core. From it the entrainment into and the circulation around the rotational core is derived. The theoretical results are compared with results from measurements on the leading-edge vortex of a sharp-edged unit aspect ratio delta wing. The measurements were performed for an angle of attack of 20 deg at 45 m/sec, corresponding to a Reynolds number of 2.5 million, based on centerline chord. A relation for the entrainment factor found in the literature is shown to be incorrect. Author (ESA)

N86-16204# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
APPLICATION OF TIME-LINEARIZED METHODS OF OSCILLATING WINGS IN TRANSONIC FLOW AND FLUTTER
M. H. L. HOUNJET and J. J. MEIJER 15 Aug. 1984 21 p refs Presented at AGARD Specialists Meeting on Unsteady Aerodynamics and Aeroelastic Applications, Toulouse, France, 2-7 Sep. 1984 Sponsored by Royal Netherlands Air Force, The Hague
(NLR-MP-84077-U; B8569322) Avail: NTIS HC A02/MF A01

Unsteady aerodynamic loads in the transonic domain were obtained with time-linearized methods in which a so-called field panel method which accounts for a proper radiation of signals towards infinity is embedded. The methods are used to predict the unsteady loads and first harmonic pressure distributions on an airfoil and a transport type wing. Results are correlated with data of unsteady experiments and of other calculation methods. Transonic flutter applications to a fighter-type configuration are described. Author (ESA)

N86-16205# Technische Hogeschool, Delft (Netherlands). Dept. of Mathematics and Informatics.
CALCULATIONS OF TRANSONIC FLOWS AROUND SINGLE AND MULTIELEMENT AIRFOILS ON A SMALL COMPUTER
Z. NOWAK 1984 32 p refs Sponsored by Netherlands Organization for the Advancement of Pure Research
(REPT-84-48) Avail: NTIS HC A03/MF A01

A method based on finite volume discretization of the full potential equation with artificial compressibility for calculating transonic flows around single and multielement airfoils is presented. The velocity potential is calculated on a succession of grids by the line-Newton method. For multielement airfoils, the channels between the component parts are treated with the line-Newton relaxation or underrelaxation procedure. The method is quite efficient for relatively coarse grids (size 21 x 64 or 17 x 64). For finer grids convergence could be improved by multigrid methods. A method for generating nearly orthogonal grids in double-connected regions using simple semianalytic formulas is given. The grids are strictly orthogonal at the inner boundary. Author (ESA)

N86-16206# European Space Agency, Paris (France).
INVESTIGATION OF THE AERODYNAMIC FORCES ON BLUFF BODIES AT HIGH REYNOLDS NUMBERS Final Report
G. SCHEWE Jun. 1985 37 p refs Transl. into ENGLISH of "Untersuch. der aerodynamischen Kraeft, die auf stumpfe Profile bei grossen Reynolds-Zahlen Wirken" Report DFVLR-Mitt-84-19 Goettingen, West Germany, 1984 Original report in GERMAN previously announced as ESA-94556
(ESA-TT-914; DFVLR-MITT-84-19) Avail: NTIS HC A03/MF A01; original German version available from DFVLR, Cologne DM 13

Steady and unsteady forces acting on a circular cylinder, a square-section cylinder and an H-profile (Tacoma Bridge) were investigated in a pressurized wind tunnel (very high Reynolds numbers). The forces were measured by a piezo-multicomponent balance, which features a large dynamic range, low interference and a high natural frequency. The Reynolds number (Re) range between 20,000 and 7 million is investigated with the same circular cylinder and balance by merely varying flow velocity and air density. In the critical Reynolds number range, bistable asymmetric flow states which can be controlled by a very small perturbation are observed. The investigation of the square section reveals no strong Reynolds number effects in the range Re between 100,000 and 4 million. The Tacoma profile is shown to be aeroelastically unstable in torsion mode. Author (ESA)

N86-17271# National Aerospace Lab., Tokyo (Japan).
NUMERICAL SIMULATION OF THE LEADING-EDGE SEPARATION VORTEX OVER DELTA WING
K. FUJII *In its* Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 27-34 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

A thin-layer Navier-Stokes code capable of predicting steady state viscous flows is applied to complicated three-dimensional flow fields. The code is written in a generalized coordinate system, and a recently developed grid generation procedure is used for the flow-field discretization. Application is made to the vortical flow over a delta wing at high angle of attack, and the computed results are compared with experimental results. The results indicate that the present method can capture the physical phenomenon well. It is served that a leading-edge separation vortex is formed over the wing, as is a secondary separation vortex near the leading edge. The flow field behind the trailing edge is also well described. Author

N86-17273# National Aerospace Lab., Tokyo (Japan).
NUMERICAL SIMULATION OF UNSTEADY FLOW AROUND AN AIRFOIL BY FINITE DIFFERENCE SOLUTION OF NAVIER-STOKES EQUATIONS
S. OGAWA and T. ISHIGURO *In its* Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 43-52 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

A numerical procedure for solving the flow field generated by a moving body is presented based on a finite difference solution of Navier-Stokes equations. A conservation-law form of the equations in a general time-varying coordinate system is derived from the Cartesian expression by applying the concept of Lie derivatives. Specifically, a moving coordinate expression of the streamfunction-vorticity formulation is derived, and is used for the analysis of the dynamic-stall phenomenon of an oscillating airfoil in incompressible flow. A computation example is given for an NACA 0012 airfoil oscillating in pitch at an amplitude of 10 deg about a mean angle of attack of 15 deg with a reduced frequency of 0.4 pi and a Reynolds number of 20,000 based on the chord length and the uniform advance speed of the airfoil. Author

N86-17278# Metropolitan Coll. of Technology, Tokyo (Japan).
TRANSONIC INTERNAL FLOW ABOUT AN AIRFOIL OSCILLATING IN PITCH: COMPARISONS BETWEEN COMPUTATION AND EXPERIMENT
T. SHIRATORI and Y. TANIDA (Tokyo Univ., Japan) *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 85-90 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

As a preliminary investigation into the relationship between the transonic flutter characteristics and the shock behavior of a transonic cascade, a numerical analysis using a finite-difference method was carried out for a cascade oscillating in pitch about its midchord anti-phase with each other and a zero stagger angle, based on an assumption of inviscid flow. The computational method was examined by comparisons of computational results with experimental results of the shock wave periodic movements due to oscillation of the cascade, unsteady surface pressure and aerodynamic instability. Although quantitative differences in both results exists, which were caused by the presence of shock-boundary interaction in real phenomenon, the present computation was useful in the investigation of qualitative aspects of the shock wave behavior, aerodynamic instability and the relations between them. In such computation, it is necessary to make the computational mesh size small in comparison to the displacement of the shock wave. Author

N86-17285# National Aerospace Lab., Tokyo (Japan).
INVESTIGATIONS ON EFFICIENT NUMERICAL METHOD FOR SUBSONIC LIFTING SURFACES
S. ANDO *In its* Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 149-162 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

This is an intermediate summary report on the numerical investigation of subsonic unsteady lifting surface. This work describes simple planar cases. Most of the results thus obtained would be fundamentally useful even for more complicated problems, such as non-planar wings or wings with finite thickness. The results are divided into the following three main parts: (1) introduction of error-index parameters E, and development of an adaptive numerical method for lifting surfaces. (2) Improvement of numerical calculation of the subsonic kernel function. (3) Development of new, accurate, fast-converging numerical methods for lifting surfaces. For two-dimensional airfoils a DLM-C method has been developed. For finite span wings a finite aerodynamic element method (DSM-CLS) and two pressure mode methods (NAM, NAS) have been developed. Author

N86-17289# Kyoto Inst. of Tech. (Japan).
NUMERICAL ANALYSIS FOR STEADY TRANSONIC FLOWS PAST AN AIRFOIL USING AF SCHEME
N. SATOFUKA and H. NISHIDA *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 193-200 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

An approximate factorization scheme has been developed for analyzing transonic flows past an airfoil. In this scheme, upwind differencing is used for introducing artificial viscosity in the supersonic region and central differencing is used in the subsonic region. The resulting simple two- and three-banded matrices are solved by the relaxation procedure. This scheme is fully implicit, and in principle can be combined with the solution adaptive method. In both sub- and super-critical cases, the computed surface pressure distributions for an NACA0012 airfoil are in good agreement with those obtained by other methods. Author

N86-17290# Kyoto Inst. of Tech. (Japan).
NUMERICAL SOLUTION OF VISCOUS COMPRESSIBLE FLOWS PAST AN AIRFOIL USING UNCONDITIONALLY STABLE EXPLICIT METHOD
N. SATOFUKA and Y. NISHIDA *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 201-212 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

An unconditionally stable explicit method has been applied to compute compressible laminar flows past an NACA0012 airfoil. The method is based on a combination of central differencing for spatial derivatives with a rational Runge-Kutta time integration scheme. Both transonic (M = 0.8) and supersonic (M = 2.0) flow cases have been calculated for various Reynolds numbers. Physically plausible results are obtained for each case within practically feasible CPU time. Author

N86-17291# Nihon Univ., Tokyo (Japan). College of Science and Technology.
NUMERICAL ANALYSIS ABOUT FLOW OVER AN AEROFOIL WITH A LARGE ANGLE OF ATTACK
K. ONO *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 213-220 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

The results of numerical computations on the dynamic stall process of a two dimensional NACA0012 airfoil oscillating in pitch between 0 deg and 20 deg incidence angles are summarized. The uniform flow Mach number is set to 0.3. The Beam-Warming finite difference algorithm is applied to solve the time-averaged compressible Navier-Stokes, the laminar compressible Navier-Stokes and the Euler equations. The grid system is constructed based on a body-fitted curvilinear coordinate system for efficient unsteady flow computations. The computational results are compared with the experimental data. The process of the formation of the leading edge separation bubble, its convection along the airfoil surface and its shedding into the wake is fairly well simulated. But the abrupt drop of the lift coefficient is not detected in the computations. Judging from the pressure coefficient distribution, the Euler equations results give the best agreement with the experiment. It suggests that the effective local Reynolds number in the turbulent calculation is smaller than that in the actual flow field. A more precise estimation of the turbulence viscosity, the artificial one and the truncation error is necessary. Author

N86-17292# Nagoya Univ. (Japan). Dept. of Aeronautical Engineering.
NUMERICAL ANALYSIS OF TRANSONIC FLOW AROUND TWO-DIMENSIONAL AIRFOIL BY SOLVING NAVIER-STOKES EQUATIONS
Y. Y. WANG and T. FUJIWARA *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 221-228 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

An effective finite-difference scheme for solving full compressible Navier-Stokes equations was initiated by Beam and Warming. The purpose of this paper is to develop that technique and apply it to the calculation of a typical subsonic or transonic, inviscid or viscous steady flow. First, the strong conservation-law form of the Navier-Stokes equations is written in Cartesian coordinates, and then transformed into a general grid system. Following the Beam-Warming difference scheme, the parameter combination delta=1/2 and theta=1 is generally adopted. After introducing spatial factorization, second-order dissipative terms are added to the left-hand side, while fourth-order terms are added to the right-hand side; the fourth-order smoothing terms are changed to second-order terms at points adjacent to the boundaries. The numerical computations were carried out only for a typical NACA 0012 airfoil. The calculations start from uniform free-stream variables throughout the flow field. The boundary conditions in the far field are free-stream. The following four cases are calculated: (1) M sub infinity = 0.63 and alpha=0, causing an entirely subsonic flow, (2) M sub infinity = 0.63 and alpha=2 degrees, the highest velocity of upper surface being close to sonic; (3) M sub infinity = 0.75 and alpha=0, when supersonic regions appear but there are no shock waves, and (4) M sub infinity = 0.75 and alpha=2 degrees, generating a shock wave over the upper flow field. Author

N86-17293# National Aerospace Lab., Tokyo (Japan).
ANALYSIS OF HIGH REYNOLDS NUMBER TRANSONIC FLOW AROUND AN AIRFOIL
N. KAWAI and N. HIROSE *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 229-234 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

High Reynolds number transonic flow around an airfoil is numerically analyzed. The implicit approximate factorization scheme is used for the Navier-Stokes equations with an algebraic eddy viscosity model of the turbulent boundary layer. The boundary conditions on the airfoil and along the wake cut are implicitly handled. Computed results of short bubble and shock-induced separation are demonstrated. Inviscid transonic flow around and airfoil is also numerically analyzed. The diagonal form of the implicit approximate factorization scheme is used for computational efficiency. Some of the results are compared with those of potential flow calculations. Author

N86-17294# National Aerospace Lab., Tokyo (Japan).
VALIDATION AND COMPARISON WITH EXPERIMENT OF A HIGH REYNOLDS NUMBER TRANSONIC FLOW AIRFOIL ANALYSIS CODE NSFOIL
N. HIROSE, N. KAWAI, K. OGUCHI, and T. KODERA *In its* Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 235-244 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

Results of the two-dimensional Navier-Stokes code, NSFOIL, are compared with wnd tunnel data. Pressure distributions for various airfoil geometries are evaluated with special emphasis given to the NACA 0012 airfoil. Reynolds number values from 1.0 to 2.0 to the 7th power and Mach numbers from 0.7 to 2.0 are considered. M.G.

N86-17295# Mitsubishi Heavy-Industries Ltd., Tokyo (Japan).
THE COMPARISON OF THE TRANSONIC AIRFOIL CALCULATION BY NSFOIL WITH THE WIND TUNNEL TEST DATA AT HIGH REYNOLDS NUMBER
J. MIYAKAWA and N. HIROSE (National Aerospace Lab., Tokyo, Japan) *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 245-254 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

Over the past decade, the progress in computational aerodynamics has been so tremendous that it can be said that designers in aircraft industries have obtained a tool for aerodynamics analysis other than wind tunnel test, which had been their only tool since the invention of the aircraft. The new technology has become an even more efficient design tool with the development of computer aided design systems for interactive processing. All of the practical aerodynamics codes, however, are inviscid or boundary-layer-corrected programs which are accurate enough for analyzing attached flows but not for separated flows. Severe design trade off for recent high performance aircraft has necessitated accurate numerical analysis of viscous separated flows. The high Reynolds number transonic airfoil analysis code NSFOIL, is expected to be a good candidate for this difficult task. This paper presents the NSFOIL computation of the transonic flow past a supercritical airfoil, along with a comparison with the experiment to show the effectiveness of the new code. Author

N86-17300# Nihon Univ., Tokyo (Japan).
THE ANALYSIS OF PRACTICAL TRANSONIC SWEPT WINGS WITH AND WITHOUT BOUNDARY LAYER EFFECTS
K. KOMATSU, E. IIDA, R. KAWAMURA, N. HIROSE (National Aerospace Lab., Tokyo, Japan), and K. MATSUNO (National Aerospace Lab., Tokyo, Japan) *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 305-312 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

A comparison of the result of numerical analysis with experimental data is made for the ONERA M-6 and the practical transonic wing model 720211. The Jameson-Caughey's transonic wing programs FLO22 and FLO27 are used. The wing aerodynamic characteristics with viscous effect are evaluated by taking into account the boundary layer friction drag. This drag is calculated by using a three-dimensional compressible boundary layer program for wings, BLAY. Finally, a viscous-inviscid interaction procedure for FLO27-BLAY is proposed, and a preliminary result is presented. Author

N86-17305 Engineering Sciences Data Unit, London (England).
ESTIMATION OF DRAG DUE TO INOPERATIVE TURBO-JET AND TURBO-FAN ENGINES USING DATA ITEM NOS. 81009 AND 84004
Jul. 1984 12 p Submitted for publication
(ESDU-84005; ISBN-0-85679-467-8; ISSN-0141-4054) Avail: ESDU

ESDU 84005 illustrates how data on windmilling drag and airflow and on spillage drag are used to predict the drag due to the inoperative engine. The data are respectively taken from ESDU 81009 and ESDU 84004, but other sources could be used. Where ESDU data are used the method is particular suited to cases where the particular engine, or intake, data are not available. Author

N86-17307 Royal Aircraft Establishment, Farnborough (England).
STUDIES OF THE FLOW FIELD NEAR A NACA 4412 AEROFOIL AT NEARLY MAXIMUM LIFT
R. C. HASTINGS and B. R. WILLIAMS 20 Dec. 1984 35 p refs
(RAE-TM-AERO-2026; BR96009) Avail: NTIS HC A03/MF A01

Measurements at Mach number 0.18 and chord-based Reynolds number 4.2 million on a constant-chord model having a NACA 4412 airfoil are compared with the results of flow field calculations. The measurements include static pressure distributions on the wing surface and on the wind tunnel walls above and below the mid-span section of the wing. The development of the upper surface boundary layer through separation (at 20% chord ahead of the trailing-edge) and on into the wake, was studied using laser anemometry. The flow field calculations are of the semi-inverse kind in which an inverse momentum-integral treatment of the shear flow, used to avoid difficulties at separation, is coupled to a direct solution of the inviscid flow problem. Results reveal the importance of shear flow in altering the disturbance introduced into the free stream by the airfoil. Measure and predictions agree well. Author (ESA)

N86-17308# National Aerospace Lab., Tokyo (Japan).
ESTIMATION OF DIVERGENCE AND FLUTTER BOUNDARIES ON SUPERSONIC PLATE WING MODELS FROM SUBCRITICAL RANDOM RESPONSES DUE TO AIR TURBULENCE
Y. ANDO, Y. MATSUZAKI, H. EJIRI, and T. KIKUCHI 1985 17 p refs In JAPANESE; ENGLISH summary
(NAL-TR-856; ISSN-0389-4010) Avail: NTIS HC A02/MF A01

The National Aerospace Laboratory (NAL) method was applied to the response data which were obtained from subcritical flutter and divergence tests conducted in the NAL supersonic wind tunnel. Backward- and forward-swept wing models were used for the flutter and divergence tests, respectively. The stationary sampled time responses were modeled by both the autoregressive moving average (ARMA) and autoregressive (AR) processes. It has been shown that both flutter annd divergence boundaries in a supersonic flow range can well be estimated as those in the transonic flow region. Author

N86-17310# Sandia National Labs., Albuquerque, N. Mex.
INTRODUCTION TO DEPLOYABLE RECOVERY SYSTEMS
J. MEYER Aug. 1985 31 p
(Contract DE-AC04-76DP-00789)
(DE86-000048; SAND-85-1180) Avail: NTIS HC A03/MF A01

This report provides an introduction to deployable recovery systems for persons with little or no background in parachutes but who are knowledgeable in aerodynamics. A historical review of parachute development is given along with a description of the basic components of most deployable recovery systems. Descriptions are given of the function of each component and of problems that occur if a component fails to perform adequately. Models are presented for deployable recovery systems. Possible directions for future work are suggested in the summary. DOE

N86-17314# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
LOW SPEED AERODYNAMIC CHARACTERISTICS OF A TWO-DIMENSIONAL SAIL WING WITH ADJUSTABLE SLACK OF THE SAIL
R. G. DENBOER 1984 38 p refs
(VTH-LR-307) Avail: NTIS HC A03/MF A01

Low speed aerodynamic characteristics of a very simple dacron airfoil were investigated in a low speed, low turbulence wind tunnel. The influence of the slack of the sail on the lift coefficient cl, drag coefficient cd, and cl/cd, was studied. Measurements were performed at chord Reynolds numbers 200,000, 300,000, and 500,000 at values of the angle of attack and slack of the sail where relatively high values of the ratio cl/cd occurred. Results show that the value (cl/cd)max of the airfoil exceeds the value (cl/cd)max of a similar configuration in which a rigid circular plate of 10% camber is used instead of a sail. Author (ESA)

N86-17316# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
TRANSONIC WIND TUNNEL TESTS OF A SWEPT SUPERCRITICAL WING-BODY MODEL, PT 8 Final Report
L. TORNGREN Feb. 1985 110 p refs
(Contract FMV-F-K-82223-75-007-07-001;
FMV-F-K-82223-76-001-21-001; FMV-F-K-82223-80-001-21-001)
(FFA-TN-1982-24) Avail: NTIS HC A06/MF A01

Wind tunnel tests were carried out in the Mach number range 0.5 to 0.99 on a swept wing-body model. The investigation comprises six-component balance measurements, wing pressure measurements, and flow visualization. Wings with and without strakes, but with the same quarter-chord sweep of 35 deg were tested on a cylindrical and an area ruled body. Pressure measurements were only done on the wing with strakes. For the model with this wing, the effects of underwing and wingtip mounted stores were also studied. Author (ESA)

N86-17320# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
APPLICATION OF A CONSTRAINED INVERSE METHOD IN THE AERODYNAMIC DESIGN OF A LOW SPEED WING-SLAT CONFIGURATION
J. A. VANEGMOND, B. VANDENBERG, and T. E. LABRUJERE 30 Sep. 1983 36 p refs
(Contract NIVR-1901)
(NLR-TR-83123-U; B8569027) Avail: NTIS HC A03/MF A01

A system for computational design of multielement airfoils was developed. It solves the inverse aerodynamic problem in an approximate way. A priori specified aerodynamic requirements and geometric requirements are minimized in a least squares way, introducing weight factors to emphasize locally aerodynamic or geometric requirements. The system was applied to a wing with slat, exhibiting unfavorable drag characteristics. The design focused on the wing nose geometry at the slat intersection. To improve the drag characteristics a target pressure distribution was defined with a reduced suction level on the wing nose. The computations

indicated that this target could be achieved with satisfactory approxiation (fulfilling at the same time a set of geometry requirements). This is confirmed by wind tunnel measurements. The tests also show a substantial drag reduction. Author (ESA)

N86-17321# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
A SYSTEM FOR COMPUTER AIDED ANALYSIS AND DESIGN OF MULTIELEMENT AIRFOILS: MAD
T. E. LABRUJERE 9 Oct. 1983 33 p refs
(Contract NIVR-1819; NIVR-1944)
(NLR-TR-83136-U; B8569026) Avail: NTIS HC A03/MF A01

A program system for interactive analysis and design of multielement airfoils in incompressible viscous flow was developed. It applies three computational methods, one for the analysis of viscous flow, one for the analysis of inviscid flow around multielement airfoils, and one for the design of multielement airfoils in inviscid flow. The latter two methods are described. Features of the design method are illustrated by numerical results.
Author (ESA)

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A86-19301
SAFE ASSOCIATION, ANNUAL SYMPOSIUM, 22ND, LAS VEGAS, NV, DECEMBER 9-13, 1984, PROCEEDINGS
Van Nuys, CA, SAFE Association, 1985, 398 p. For individual items see A86-19302 to A86-19353.

The present conference on aircraft life support and escape systems considers the fire safety of commercial aircraft cabins, acceleration exposure limits for escape system development, the development of a zero-prebreathe spacesuit, an impermeable chemical defense protective ensemble, crew escape capsule technology, helicopter escape methods, an altitude and acceleration protection system for high performance aircraft, molecular sieve oxygen supply systems, vectored thrust digital control of ejection seats, and ballistically deployed parachutes for small aircraft. Also discussed are control law and logic development for an ejection seat catapult, real time recovery of vehicle data, escape system simulation methods, an underwater high pressure emergency breathing system, simulator sickness, decompression sickness, and the use of gliding parachutes for ejection seats.
O.C.

A86-19319
BALLISTICALLY DEPLOYED PARACHUTE SYSTEMS FOR SINGLE AND TWO PLACE AIRCRAFT
P. J. WOODRUFF (Pioneer Parachute Co., Inc., Manchester, CT) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 128-131.

Ballistically deployed parachute systems have been developed for single- and two-place aircraft. A parachute system which utilizes a 29-foot nominal diameter parachute is used to recover the 'FlightStar', an aircraft which meets ultralight requirements. A parachute system which utilizes a 36-foot nominal diameter parachute is used to recover single-place aircraft which do not meet ultralight requirements, as well as the 'DualStar', a two-place ultralight training aircraft. Author

A86-19323
ACCIDENT INVESTIGATION AS A WAY OF ASSESSING AVIATION LIFE SUPPORT SYSTEM PERFORMANCE
B. W. TRENHOLM (U.S. Navy, Naval Weapons Center, China Lake, CA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 151-156.

Separately and statistically, the Aviation Life Support Systems (ALSS) survival equipment involved in ejections and crashes provides real-life data on its performance. An inspection process for the accident-involved ALSS equipment has been developed to assist in identifying and correcting potential problems. The procedure consists of an in-depth inspection of all recovered components performed in the functional/operational sequence of the parachute assembly: (1) the external pilot chute, (2) the override disconnect, (3) the internal pilot parachute, (4) the main canopy, (5) the suspension lines, (6) the spreading gun assembly, (7) the riser assemblies, (8) the cross-connector straps, (9) the canopy release fittings (female halves), (10) the automatic parachute ripcord release assembly, (11) the container, (12) the MA-2 torso harness, and (13) the parachute assembly configuration. All findings are documented on applicable damage charts, establishing a logical procedure for determining the step or steps in the parachute assembly that malfunctioned. I.S.

A86-19326
USING FLEET REPORTED 3-M DATA IN SUPPORT OF NAVY EMERGENCY ESCAPE PARACHUTE ASSEMBLIES
M. A. MARTIN (U.S. Navy, Naval Weapons Center, China Lake, CA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 164-168.

The Fleet Support Branch of the Aerosystems Department, Naval Weapons Center (NWC), has the task to perform failure trend analyses on the basis of the Maintenance and Material Management (3-M) data for Navy emergency escape parachute assemblies and ther components. Details regarding the involved operations and the data bases are discussed, and the significance of the analyses is evaluated. When used in conjunction with the quality deficiency reporting system, the technical publication deficiency reporting system, and the accident investigation reports, 3-M allows an organized approach to the solution of Fleet parachute problems. G.R.

A86-19334
THE CANADIAN FORCES TWIN OTTER AIRCRAFT OPERATIONS IN THE ARCTIC - A THERMAL ASSESSMENT
G. R. GAMBLE and T. ROMMET IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 212-215.

The objectives of this paper were to assess the degree of cold stress that Twin Otter aircrew are subjected to during Arctic operations, and to determine what equipment inadequacies or deficiencies were producing the high level of cold stress reported by aircrew working in this environment. Various physiological and environmental monitoring systems were utilized to assess the effects of the environment on crew members. Although comfort levels were low, no signs of even mild hypothermia were observed, however, instances of conductive cooling due to fuel spillage were observed. Improved thermal protection of the face is required, as is fuel and water protection of the hands and feet. A lightweight heater to raise aircraft interior temperatures after lengthy shut-downs would also be an asset. Author

A86-19335
THE ANATOMY OF SEA SKAD (SURVIVAL KIT AIR DROPPABLE) - A CANADIAN FORCES/INDUSTRY DEVELOPMENT PROGRAM
C. B. LOCKETT IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 216-219.

The present paper is concerned with the development of a survival kit of system which is dropped from an aircraft to persons in distress at sea. In Canada, search and rescue operations are a responsibility of the Defense Department. The SKAD project was started in connection with a requirement for Maritime Command to fulfill its secondary search and rescue (SAR) mandate with the new long range patrol aircraft, the P-3 Orion, which is called Aurora. It is pointed out that frequently these aircraft are the only Canadian Forces resource with the necessary speed, range, and endurance to perform specific tasks in the more remote regions of Canada's area of responsibility. Attention is given to efforts to seek a source of SKAD development from Canadian industry, the selection of a suitable company, the start of the development in late 1981, problems of functional demonstration, and the start of production. Each SKAD consists of two 10 person life rafts and sufficient equipment for up to 20 survivors. G.R.

A86-19352
A PHILOSOPHICAL BASIS FOR THE USE OF HIGH-PERFORMANCE, GLIDING PARACHUTES IN EJECTION SEAT AIRCRAFT
M. C. BUTLER, JR. (U.S. Navy, Naval Weapons Center, China Lake, CA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 356-361.

A ram-air inflated, gliding parachute wing capable of meeting or exceeding the performance of a round parachute in all categories, from opening shock to landing impact, is described. One of the major advantages of the ram-air parachute (RAP) over the round parachute (RP) is its inherent gliding capabilities, which increase, by a factor of 39, the area that the enemy must search in order to find the ejectee. Other advantages include the extremely fast opening characteristics of RAP, its stability in all flight modes, and its much lower rate of descent than that of an RP of comparable pack volume. A rate of descent of 15 ft/s at 300 lb suspended weight has been demonstrated at an L/D of 2.5. Data available indicate that the RAP is much more reliable than the RP when compared in the same type of applications. The costs and the time required to manufacture an RAP are the same as those of an RP. I.S.

A86-19353
COMPENSATING-SLIT CANOPY DESIGN - A NEW LOW-SPEED/HIGH-SPEED PARACHUTE
D. C. HASS (U.S. Navy, Naval Weapons Center, China Lake, CA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 362-366.

The Naval Weapons Center's (NWC's) 'compensating-slit' parachute was developed to meet a requirement for a singular parachute canopy design that would possess desirable opening shock and descent characteristics at both low and high operational airspeeds. Through the employment of a properly located tear-out slit around the perimeter of the canopy, which remains closed at low airspeed openings and opens at high airspeed openings, this parachute concept enjoys a dual-personality characteristic which results in desirable performance at both ends of the operational airspeed spectrum. Phase one of a two-phase test program, consisting of Whirltower tests and aircraft drop tests under varied test conditions, has been accomplished. Modified, standard 28-foot-diameter, flat, circular canopies (28FCs) were used in phase one because of their low cost and ease of fabrication. However, the newly-developed compensating-slit canopy is being used in phase two. Author

A86-19637*# National Severe Storms Lab., Norman, Okla.
LIGHTNING STRIKES TO A NASA AIRPLANE PENETRATING THUNDERSTORMS AT LOW ALTITUDES
V. MAZUR (NOAA, National Severe Storms Laboratory, Norman, OK), B. D. FISHER (NASA, Langley Research Center, Hampton, VA), and J. C. GERLACH (NASA, Wallops Flight Center, Wallops Island, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p. refs
(AIAA PAPER 86-0021)

The NASA Storm Hazards program was dedicated during the 1984 storm season to a study of lightning strikes on an instrumented F-106B aircraft, during penetrations of thunderstorms at altitudes lower than the 6-8 km center of lightning flash density. These altitudes coincide with the negative charge region of thunderstorms. An analysis of the correlation between the UHF band radar data obtained and TV images of lightning strikes indicates that, with a known aircraft position relative to the radar, the lightning channel motion can be adequately interpreted on the basis of radar echo evolution. O.C.

A86-19737#
WIND SHEAR CHARACTERIZATION
H.-P. CHANG, D. W. CAMP (FWG Associates, Inc., Tullahoma, TN), W. FROST (Tennessee, University, Tullahoma), and J. MCCARTHY (National Center for Atmospheric Research, Boulder, CO) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0180)

Computer simulations of a B727 type aircraft flying through the JAWS microburst wind shear data have been developed and the results evaluated. The results are in good agreement with those obtained from the NASA/Ames B727 piloted simulator. The aircraft trajectory deviations from the intended flight path at the ILS CAT II decision height window are calculated for finding critical penetration heights through the center of the microburst. Based on the aircraft's dynamic responses in the simulations, the JAWS microburst wind fields are classified into light, moderate, and severe cases, which represent interesting simulator training scenarios. Finally, the wind shear effects on three generic types of aircraft, a three-engine passenger airliner, a twin-engine STOL, and an executive jet, are investigated. Large jet aircraft experience greater difficulty in flight through microburst wind shear fields than smaller aircraft. Author

A86-19813#
DETERMINING THE EFFECTS OF WEATHER IN AIRCRAFT ACCIDENT INVESTIGATIONS
J. C. MCLEAN, JR. (National Transportation Safety Board, Washington, DC) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 7 p.
(AIAA PAPER 86-0323)

Weather is often a principal factor in aircraft accidents and the documentation and analysis of the weather elements becomes a major part of the accident investigation. Selected accident investigations are reviewed to describe some of the techniques used to determine what weather elements may be pertinent or critical to an accident, the sources of weather information, and the methods of analyzing the information to satisfy the requirements of the investigation. Author

A86-19814#
METEOROLOGICAL FACTORS IN SELECTED AIRCRAFT ACCIDENT INVESTIGATIONS
R. E. CALE (E.R.A. Services, Inc., Cerritos, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 6 p.
(AIAA PAPER 86-0324)

Post-analysis of accident environments provides an opportunity for considerably better meteorological information than is possible with forecast services. This is due to having data after the fact as well as before, and the time to pursue in-depth analysis of available data - specializing the effort to each particular problem. Examples are given from a number of case studies of the use of applied meteorological techniques to determine environmental factors

useful to aeronautical experts in determining probable cause. Author

A86-19815#
WEATHER-INVOLVED U.S. AIR CARRIER ACCIDENTS 1962-1984 - A COMPENDIUM AND BRIEF SUMMARY
R. D. RUDICH (Air Transportation Consultants, Ltd., Alexandria, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 8 p. refs
(AIAA PAPER 86-0327)

The documentation of 32 aircraft accidents which occurred over the past quarter century and were related to weather phenomena are summarized. All the accidents were investigated by the NTSB and the findings are cited. A total of 16 types of passenger aircraft were involved in the accidents, which resulted in a total of 789 fatalities and 321 additional serious injuries. Thunderstorms were the most frequent meteorological condition associated with accidents, closely followed by severe wind shear (microburst) events. Failures of cockpit personnel and aircraft-ATC to communicate available weather data are frequently cited as the situations which led to the accidents. M.S.K.

A86-19860*# Massachusetts Inst. of Tech., Cambridge.
REAL-TIME MEASUREMENT OF ICE GROWTH DURING SIMULATED AND NATURAL ICING CONDITIONS USING ULTRASONIC PULSE-ECHO TECHNIQUES
R. J. HANSMAN, JR. and M. S. KIRBY (MIT, Cambridge, MA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. FAA-supported research.
(Contract NGL-22-009-640)
(AIAA PAPER 86-0410)

Results of tests to measure ice accretion in real-time using ultrasonic pulse-echo techniques are presented. Tests conducted on a 10.2 cm diameter cylinder exposed to simulated icing conditions in the NASA Lewis Icing Research Tunnel and on an 11.4 cm diameter cylinder exposed to natural icing conditions in flight are described. An accuracy of + or - 0.5 mm is achieved for real-time ice thickness measurements. Ice accretion rate is determined by differentiating ice thickness with respect to time. Icing rates measured during simulated and natural icing conditions are compared and related to icing cloud parameters. The ultrasonic signal characteristics are used to detect the presence of surface water on the accreting ice shape and thus to distinguish between dry ice growth and wet growth. The surface roughness of the accreted ice is shown to be related to the width of the echo signal received from the ice surface. Author

A86-20162#
THE LIGHTNING THREAT TO AEROSPACE VEHICLES
P. L. RUSTAN, JR. (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 62-67. Previously cited in issue 07, p. 851, Accession no. A85-19516. refs

A86-20166#
APPLICATION OF KEVLAR TO PARACHUTE SYSTEM DESIGN
C. W. PETERSON, W. B. PEPPER, D. W. JOHNSON, and I. T. HOLT (Sandia National Laboratories, Albuquerque, NM) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 87-92. Previously cited in issue 11, p. 1498, Accession no. A84-26574. refs
(Contract DE-AC04-76DP-00789)

A86-20411
AIRPORT PREPAREDNESS FOR MASS DISASTER - A PROPOSED SCHEMATIC PLAN
G. I. BARBASH, S. M. RUSKIN, D. W. MOELLER (Harvard University, Boston, MA), and N. YOELI (Israel Air Force, Aeromedical Center, Ramat Gan) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 57, Jan. 1986, p. 77-81. refs

The characteristics which make airport accidents different from other nonaircraft accidents are described. Immediate evaculation of the casualties and their transport to medical facilities is the basis of an airport rescue operation. The utilization of the airport crew, close medical aid, and distant medical facilities is examined. The notification of the medical personnel of an emergency and means of providing orientation and guidance for them at the airport are analyzed. Management of the crash site, including development of the medical staff and evacuation and treatment of the casualities, especially burn victims and uninjured passengers, by a command group, is discussed. The advantages of practicing a disaster plan are addressed. I.F.

N86-16207# National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation.
AIRCRAFT ACCIDENT REPORT: MIDAIR COLLISION OF WINGS WEST AIRLINES BEECH C-99 (N666U) AND AESTHETEC INC., ROCKWELL COMMANDER (N112SM), NEAR SAN LUIS OBISPO, CALIFORNIA, AUGUST 24, 1984
24 Aug. 1984 52 p
(NTSB/AAR-85/07) Avail: NTIS HC A04/MF A01

At 1117:38 Pacific daylight time, on August 24, 1984, Wings West Airlines, Flight 628, a Beech C-99 (N6399U), and Aesthetec Inc., Rockwell Commander 112TC, N112SM, collided in midair near San Luis Obispo, California. The weather at the time of the collision was clear. Flight 628 had just departed San Luis Obispo County Airport en route to San Francisco International Airport, California, and was climbing on a westbound heading. The Rockwell Commander had departed Paso Robles, California, on a training flight and was descending toward the San Luis Obispo County Airport on an eastbound track. The airplanes collided head-on at an altitude of about 3,400 feet. The wreckage of both airplanes fell into an open field 8 nmi west northwest of the San Luis Obispo County Airport. All 17 persons, including the 2 pilots and 13 passengers onboard flight 628 and the 2 pilots onboard the Rockwell, were killed. The National Transportation Safety Board determines that the probable cause of this accident was the failure of the pilots of both aircraft to follow the recommended communications and traffic advisory practices for uncontrolled airports contained in the Airman's Information Manual to alert each other to their presence and to enhance the controller's ability to provide timely traffic advisories. Author

N86-16208*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SOME COMPARISONS OF US AND USSR AIRCRAFT DESIGN DEVELOPMENTS
M. L. SPEARMAN Dec. 1985 36 p refs Previously announced in IAA as A86-10930
(NASA-TM-87611; NAS 1.15:87611) Avail: NTIS HC A03/MF A01 CSCL 01C

A review is given of the design and development of some US and USSR aircraft. The emphasis is on the historical development of large aircraft-civil and military transports and bombers. Design trends are somewhat similar for the two countries and indications are that some fundamental characteristics are dictated more by ideological differences rather than technological differences. A brief description is given in a more or less chronological order of the major bomber aircraft, major civil and military transport aircraft, and the development of the air transport systems. Author

N86-17324# Committee on Science and Technology (U. S. House).
CONTROLLED IMPACT DEMONSTRATION (CID)
Washington GPO 1985 82 p Hearing before the Subcommittee on Transportation, Aviation and Materials of the Committee on Science and Technology, 99th Congr., 1st Sess., no. 13, 2 Apr. 1985
(GPO-46-870) Avail: Subcommittee on Transportation, Aviation and Materials

A congressional hearing was conducted and expert testimony presented on the controlled impact demonstration. The experimental worth of crashing an airplane for the purpose of gaining hard data on crashworthiness was discussed. G.L.C.

N86-17325# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
HARDWARE/SOFTWARE FAILURE MODE EFFECT ANALYSIS (FMEA) APPLIED TO AIRPLANE SAFETY
J. B. J. VANBAAL 31 Jul. 1984 9 p refs Presented at 1985 Annual Reliability and Maintainability, Philadelphia, Pa., 22-24 Jan. 1985
(NLR-MP-84073-U; B8568107) Avail: NTIS HC A02/MF A01

A systematic, analytical methodology for aircraft system safety assessment is explained. A try-out on a software controlled digital avionics system is summarized. Analysis of software components is emphasized. It is concluded that the same methodology can be applied to software and hardware. Conditions that have to be met to perform a successful hardware/software safety assessment are described. Author (ESA)

N86-17328# Societe Nationale Industrielle Aerospatiale, Marignane (France). Helicopter Div.
THE DEICED SUPER PUMA
J. P. SILVANI 1985 10 p refs Presented at 11th European Rotorcraft Forum, London, England, 10-13 Sep. 1985
(SNIAS-852-210-104) Avail: NTIS HC A02/MF A01

The efficiency of helicopter ice protection systems was studied in flight test with natural icing conditions, in icing wind tunnel tests and analytically. The icing wind tunnel tests were intended to develop and validate air intake and horizontal stabilizer icing protections. Proper operation of all protections is verified in natural icing flight down to -20 C in continuous and intermittent icing conditions. Author (ESA)

N86-17329# Societe Nationale Industrielle Aerospatiale, Marignane (France). Helicopter Div.
SEARCH AND RESCUE (SAR) SYSTEM DEVELOPED AS PART OF THE CONTRACT SIGNED WITH THE IRISH AIR CORPS FOR THE SUPPLY OF 365 F DAUPHIN AIRCRAFT
S. RIOCHE 1985 15 p Presented at 11th European Rotorcraft Forum, London, England, 10-13 Sep. 1985
(SNIAS-852-210-105) Avail: NTIS HC A02/MF A01

A helicopter-borne search and rescue system, including a fully automatic guiding function and an electronic flight instrument system was developed. The first includes automatic search patterns and descent to hovering near the designated target, implemented by a navigation computer and a flight director computer. The second includes a display of horizontal situation parameters, attitude and radar. The versatility of the system makes it compatible with a wide variety of other requirements, both civil and military. Author-(ESA)

N86-17330# Societe Nationale Industrielle Aerospatiale, Les Mureaux (France). Div. Systemes Balistiques et Spatiaux.
SYSTEMS SAFETY: PHANTOM OR REALITY [SECURITE DES SYSTEMES: FANTOME OU REALITE]
P. LAVEDRINE 1985 10 p In FRENCH Presented at 3rd Seminaire Europeen sur la Securite des Systemes, Cannes, France, 19-21 Sep. 1984
(SNIAS-852-422-103) Avail: NTIS HC A02/MF A01

The juridical aspects of manufacturer's liability in case of safety failure, particularly in the case of aircraft accidents, are discussed. The moral aspects and responsibilities of designers are examined. Author (ESA)

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A86-20520
AIRCRAFT TERMINAL AREA GUIDANCE BASED ON THE DISCRETE TRACKING PROBLEM OF OPTIMAL CONTROL THEORY
J. E. MARINE and J. E. BENNETT (Clemson University, SC) IN: SOUTHEASTCON '84; Proceedings of the Conference, Louisville, KY, April 8-11, 1984 . New York, Institute of Electrical and Electronics Engineers, 1984, p. 399-402. refs

An aircraft terminal area landing approach system based upon the Discrete Tracking Problem of Optimal Control Theory is presented. The control vector is made up of the aircraft's thrust and flight path. An example of the landing approach system is presented. Author

A86-21327
LOCAL AREA COMMAND/CONTROL NETWORKS: THE DESIGN OF AN ON-BOARD NETWORK - ANTINEA [RESEAUX LOCAUX DE COMMANDE-CONTROLE: CONCEPTION D'UN RESEAU EMBARQUE - ANTINEA]
J.-C. VALADIER Toulouse, Institut National Polytechnique, Doctorat Thesis, 1985, 142 p. In French. refs

A design is proposed for a local area network (LAN) for use on aircraft. The LAN is intended for avionics system which feature distributed interconnected computers. In aircraft, operations must be in real-time with a reaction time of less than 0.5 msec to avoid compromising flight safety. The ANTINEA project was initiated in 1982 to develop a second generation LAN which would acommodate distributed command/control points. The goal was to increase the number of possible data exchanges, lower the access time, and ensure reliability in the system. The ANTINEA system includes 40 Mbps operational rate using optical fiber links. Each signal travels unidirectionally through a repeater unit, which may be redundant. Simple computations can be carried out on a decentralized basis, while overall computational reliability is directly dependent on the extent of redundancy built into this token ring system. Reliability is further enhanced if the system architecture includes a backup token ring. Finally, techniques are discussed for assigning priorities to control the data traffic and minimize the system access time. M.S.K.

A86-21606
EVOLUTION OF THE AIR TRAFFIC CONTROL BEACON SYSTEM
C. F. PHILIPS (Westinghouse Defense and Electronics Systems Center, Baltimore, MD) The Controller (ISSN 0010-8073), vol. 24, Dec. 1985, p. 18-20, 22-24.

The operation of the air traffic control (ATC) beacon system in modes A and C is described. The interference problem in the controller's display resulting from the increased number of aircraft with transponders is investigated; the synchronization of replies with the interrogation rate of the ground interrogator and staggering of regional interrogation rates eliminates this interference. The operation of the sidelobe suppression system designed to reduce sidelobe interference is examined. The development of a 5 foot high open array to reduce interference is discussed. The design of mode S, which reduces the number of ground interrogations, for the operation of the beacon system is described. The monopulse processing, selective interrogation, and digital data link of mode S are analyzed. I.F.

A86-21607
RADARS IN AIR TRAFFIC CONTROL - A STATUS REPORT
P. A. JORGENSEN (Selenia S.p.A., Rome, Italy) The Controller (ISSN 0010-8073), vol. 24, Dec. 1985, p. 25-27.

Advances in radar system designs are discussed. The advantages and function of a multiradar tracking (MRT) system, which utilizes all available radar data to develop a one system track for each aircraft, are examined. The operation of the radar head processor (RHP), which combines data from all radar systems and performs local tracking, is described. MRT and RHP are to reduce the error in range and azimuth. The testing of the MRT and RHP is analyzed. I.F.

A86-21608
PLESSEY DISPLAYS IN AIR TRAFFIC CONTROL
A. FIELD The Controller (ISSN 0010-8073), vol. 24, Dec. 1985, p. 30-32.

Technological advances which have increased the application of radars to air traffic control are: (1) improved performance of primary radar sensors, (2) the development of a secondary surveillance, (3) digital data processing, and (4) display changes. The design and functions of Watchman, a new generation of autonomous intelligent displays, are examined. The display, which has improved clarity, and the console, which contains a display and data processing system, are integrated. The capabilities the display adds to the radar presentations are listed. The ability of the controller to access all available data as desired is studied. An example of a controller's data display request is provided. I.F.

N86-16209 Civil Aviation Authority, London (England).
EVALUATION OF 23 INCH RADAR VIEWING UNIT FOR HEATHROW APPROACH CONTROL ROOM
Jul. 1985 24 p refs
(CAA-PAPER-85011; REPT-516) Avail: Issuing Activity

The possibility of replacing pairs of 16 in approach radar viewing units (RVU) by single 23 in units was assessed in a simulation with 20 air traffic controllers. The subjective and numerical evidence indicates that a single 23 inch RVU is an acceptable replacement. The lack of suitable range settings made it difficult for controllers to comment about the suitability of the RVU for the initial planning task. However, the indications are that the monitoring and sequencing tasks could be carried out satisfactorily. In the event of an RVU failure, a controller could maintain a radar service for a maximum of 5 min by sharing a neighboring RVU. Author (ESA)

N86-17331 Bundesanstalt fuer Flugsicherung, Frankfurt am Main (West Germany).
ACTIVITIES IN AIR TRAFFIC CONTROL Annual Report, 1984
Jun. 1985 50 p In GERMAN
Avail: Issuing Activity

Measures to enhance air traffic safety and regularity, performance of air traffic services, operational problems, and air traffic incidents are discussed. Navigation and radiotelephony techniques, information transmission techniques, radar techniques, and air traffic control technical services are described. Activities of the office for passenger information, flight measurements, construction plans, education and advanced training, and cooperation in the framework of international aviation organization are summarized. Author (ESA)

N86-17333# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abt. Traegheitsortung und Navigation.
CONSTRUCTION OF A MEASURING METHOD USING FIBER OPTICS AND AN LTN-90 LASER GYRO STRAPDOWN SYSTEM FOR BO-195 HELICOPTERS
H. J. HOTOP and H. P. ZENZ May 1985 48 p refs In GERMAN; ENGLISH summary
(DFVLR-MITT-85-10; ISSN-0176-7739) Avail: NTIS HC A03/MF A01; DFVLR, Cologne DM 19

A Modular Universal Data Acquisition System 2 (MUDAS 2) equipped with an LTN-90 laser gyro strapdown navigation system and with a fiber optic data bus for transmission of ARINC-429 signals was developed for onboard testing of navigation systems. It was tested on a BO-105 helicopter during flights for applicability on helicopters and flexibility in data acquisition and recording. The system was studied on long distance flights and on strong maneuver flights. Signals of the LTN-90 system were compared with the data of the Precision Automated Tracking System laser radar. Application of fiber optics for data transmission of bit serial signals (200 Hz NRZ Code) is proved. The LTN-90 navigation system designed for surface aircraft can be applied without loss of accuracy. Author (ESA)

N86-17334# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
A SOPHISTICATED TRACKING ALGORITHM FOR AIR TRAFFIC CONTROL (ATC) SURVEILLANCE RADAR DATA
H. A. P. BLOM 9 Jan. 1984 10 p refs Presented at International Conference on Radar, Paris, France, 21-24 May 1984
(NLR-MP-84004-U; B8566260) Avail: NTIS HC A02/MF A01

An algorithm based on martingale tools for application to sudden aircraft maneuvers in radar tracking was developed. It is a Markov jump-diffusion model. It provides very accurate state estimates during unchanged flight modes, very fast reaction and convergence after changes, and good estimates of its own accuracy. Comparison with an alpha-beta tracker, a Kalman based tracker, and a state-of-the-art tracker proves the superior performance of the algorithm. Author (ESA)

N86-17335# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
COMPARISON OF A JUMP-DIFFUSION TRACKER WITH A KALMAN TRACKER: AN EVALUATION WITH EMPHASIS ON AIR TRAFFIC CONTROL
H. A. P. BLOM 30 Mar. 1983 39 p refs
(NLR-TR-83063-U; B8569022) Avail: NTIS HC A03/MF A01

Radar tracking algorithms are compared. A probabilistic approach to the tracking problem is a Markov jump-diffusion model for the aircraft dynamics, its control, and the radar measurements. From nonlinear filtering theory, a closed form description of the evolution of the conditional distribution of this Markov process can be obtained. This jump-diffusion filter, however, is infinite dimensional and approximations are necessary for algorithmic implementation. The indirect approach of approximating the jump-diffusion by a diffusion leads to a Kalman-like tracker. The approach of approximating the jump-diffusion filter directly leads to a bank of interacting Kalman-like trackers. Comparison for air traffic control shows that the jump-diffusion tracker performs considerably better than the Kalman tracker. Author (ESA)

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A86-19303
A SINGLE POINT RELEASE SYSTEM FOR THE ADVANCED CONCEPT EJECTION SEAT (ACES) II - SURVIVAL KIT AND PARACHUTE RISERS
T. N. WHITEHURST, JR. (Boeing Services International, Inc., Houston, TX) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 41-45. refs
(Contract F33657-81-C-0368)

Attention is given to the electroexplosive system developed to provide the Advanced Concept Ejection Seat II with a safe and reliable Single Point Release System (SPRS) employing automatic, sea water-activated parachute riser releases. Design features and performance factors of the SPRS are presented. Tests of the prototype SPRS have been conducted with two F-16 seats, occupied by dummies and filmed at 200 frames/sec. O.C.

A86-19305
YAW STABILIZATION OF AN OPEN EJECTION SEAT, FACT OR FANTASY?
W. R. PECK (Stencel Aero Engineering Corp., Asheville, NC) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 51-54.

A discussion is presented of efforts to date toward the development of yaw stabilization systems for high performance aircraft ejection seats, having as a goal the reduction of crew injuries due to lateral accelerations. Such systems entail compatibility with existing aircraft cockpits, and stabilization elements that are passive and aerodynamic in nature. Attention is given to several preposessing designs, as well as to Mach 0.3 and 0.75 aerodynamic data obtained through wind tunnel testing of one of these devices. O.C.

A86-19306
THE FUTURE OF ADVANCED CREW ESCAPE CAPSULE TECHNOLOGY
D. E. MCCAULEY (McDonnell Aircraft Co., St. Louis, MO) and M. I. DARRAH (McDonnell Douglas Corp., St. Louis, MO) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 59-62.

This presentation reviews technology and biodynamics pertinent to crew escape for future high performance fighters. It discusses various capsules and their materials, supporting subsystems, limits, and adaptations necessary to permit survival when conditions exceed human tolerance. Hazards associated with escape are also presented, including temperature extremes, hypoxia, low pressure, and high accelerations. Discussions will emphasize high speed, high altitude atmospheric fighters, and transatmospheric vehicles. The escape capsule systems of the future will require continual sensing of critical parameters, offering the prognosis of an artificially intelligent escape system, predicated on life support of the crew. Author

A86-19307
DEVELOPMENT OF MECHANICAL COMPONENTS FOR ADVANCED AIRCREW SEATING SYSTEMS
R. L. FARRIS (Pacific Scientific Co., Kin-Tech Div., Anaheim, CA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 63-66.

A discussion is conducted concerning the development status, design features and obtainable performance of mechanical components used in the crew seats of advanced aircraft as safety/escape devices. Attention is given to crew harness inertia reels, harness systems, lap belt cinchers, inflatable head and body restraints, infinite rotary positioners, vapor springs, and mechanical linear load limiters. Both rotary and fixed wing aircraft crew seating equipment are considered. O.C.

A86-19308
THE CONTINUING REQUIREMENT FOR HELICOPTER ESCAPE
W. L. TRAYNOR (Stencel Aero Engineering Corp., Asheville, NC) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 67-70. refs

An evaluation of the development history of helicopter crew survivability measures and devices in the U.S. leads to the observation that efforts have concentrated in the area of vehicle crashworthiness to the exclusion of in-flight escape. It is noted that the high helicopter damage probability experienced in Vietnam conflict battles as a result of heavy Soviet-built machine gun fire has direct implications for future encounters of such weapons by U.S. combat helicopters. O.C.

A86-19311
F-111 ESCAPE SYSTEMS - TODAY'S MODULE TECHNOLOGY
G. W. LARSON (General Dynamics Corp., Fort Worth, TX) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 77-80.

The crew module, in its use in the F-111, has proven to be an excellent escape system. The first ejection occurred in October 1967. Statistically, since that time the percentage of safe ejections has been equal to or better than that of open seat systems. Because of the large number of explosive components in the module, the major effort for improvements has been toward extending the service life of these units. New developments in fabrication techniques that permit the design of hermetically sealed subassemblies now provide life-of-airplane capability for explosive devices. Author

A86-19314
ALTITUDE AND ACCELERATION PROTECTION SYSTEM FOR HIGH PERFORMANCE AIRCRAFT
A. GUPTA and M. B. MCGRADY (Boeing Military Airplane Co., Seattle, WA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 95-98.

An advanced, integrated breathing and anti-G system capable of providing aircrew protection for altitude exposures up to 60,000 feet and sustained accelerations up to 9 G(Z) is presented. The system utilizes an On-Board Oxygen Generating System controlled by a fast response fluidic oxygen partial pressure sensor, and a fast acting electronic anti-G valve. Significant features include (1) automatic selection and control of breathing gas supply, (2) simultaneous controlled pressurization of G-suit, jerkin, mask and mask-tensioning bladders, (3) low breathing resistance, (4) simple control and indication, and (5) high system integrity during probable failure conditions or ejection. Author

A86-19316
AIRCREW ESCAPE SYSTEM MODELS USED IN WIND TUNNEL TESTS
F. J. SACKLEH (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 103-108.

The AEDC 16-ft and 4-ft transonic wind tunnels (16T and 4T) have supported the development of ejection seats for Air Force aircraft. This paper describes the wind tunnel models and model supporting hardware used on representative tests and also describes planned improvements in separation test capabilities. In the 16-ft transonic wind tunnel, subscale models of developmental ejection seats and capsules have been tested. Instrumentation

include internally mounted six-component balances, anthropomorphic dummies with surface strain gages, and pressure transducers. Jettison plumes are simulated with high-pressure air, and effectiveness of various stabilizing devices are evaluated. Model attitudes are varied within wide ranges of pitch angle and yaw angle. In the 4T transonic wind tunnel, a separation test using two separate stings for canopy and aircraft was recently accomplished. This two-sting capability is also planned for the larger 16-ft wind tunnel. Author

A86-19317
DEVELOPMENT OF AN ELECTRO-PNEUMATIC ANTI-G VALVE FOR HIGH PERFORMANCE FIGHTER AIRCRAFT
R. E. VAN PATTEN, T. J. JENNINGS, W. ALBERY, J. W. FRAZIER (USAF, Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH), and C. GOODYEAR (Systems Research Laboratories, Inc., Dayton, OH) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 112-116. USAF-supported research. refs

A new concept for an anti-G suit valve was designed and built at the Air Force Aerospace Medical Research Laboratory. The valve is designed specifically to protect aircrew from the unique physiological hazard of high onset rate, high sustained acceleration. The design is a hybridization of a conventional inertially operated valve, and uses an electronically controlled solenoid to drive the anti-G suit pressure to the maximum when the level of acceleration exceeds both +2 G(z) and an onset rate of 2 G/sec. After a 1.5-sec period, the valve reverts to inertial operation unless the trigger criteria are fulfilled again. Relaxed tolerance of 15 human subjects was determined under high rate of onset centrifuge testing of the new valve (with and without ready pressure) versus the standard valve and a high flow ready pressure valve. The new concept provides a 1 G improvement over the standard valve, and a 0.5 G improvement over the high flow ready pressure valve. On the basis of published data taken under similar conditions, the new valve appears to provide a 0.5 G improvement over all electronic servo valves. Pilot acceptance of this rapid acting concept has been favorable. Author

A86-19318
VECTORED THRUST DIGITAL CONTROL OF EJECTION SEATS
J. V. CARROLL (Scientific Systems, Inc., Cambridge, MA) and M. K. KLUKIS (Martin Marietta Engineering Computer Center, Orlando, FL) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 117-121. USAF-supported research. refs

A closed loop control law design for open ejection seats is presented and discussed. The combination of worsening survival statistics during crew escape in recent years and improving control component technology has made such a study timely and practical. The control technique is based on nonlinear acceleration control, which exploits very well the unique and highly nonlinear characteristics of the pilot/seat system. This paper reviews the design of the controller, including the related actuator configuration and microprocessor architecture issues. A breadboard hybrid simulation, utilizing a wire-wrapped electronic digital controller and a unique vectored thrust actuation concept, has been developed for real time analysis of the concept and is also discussed in this paper. This real time ejection seat controller breadboard analysis capability represents a major step in the evolution of the 'smart' seat, from concept and digital simulation to fabrication, sled testing and production. This design represents a reasonable approach for the control of the seat in its harsh, highly constrained environment, over diverse escape conditions. Author

A86-19320
CONTROL LAW AND LOGIC DEVELOPMENT FOR CONTROLLABLE EJECTION SEAT CATAPULT
A. K. TRIKHA (Boeing Military Airplane Co., Seattle, WA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 132-137.
(Contract F33615-83-C-3045)

An adaptive ejection seat catapult has been developed which can adjust its thrust to variations in seat/crewperson weight, propellant temperature, and airplane g values. As a result, the rail tipoff velocity can be maximized without exceeding the crewperson's dynamic response index. Simulation results are presented to show that the objective has been met for flight conditions with variations in crewmember/seat weight between 272 to 444 lb, operating temperatures ranging from -65 to +160 F, and the aircraft acceleration of +10 g (compression) to -3 g (tension). The catapult diagram and the control law and logic diagram are included. I.S.

A86-19331
A MICROPROCESOR SEQUENCER FOR THE ADVANCED NAVY EJECTION SEAT
P. AYOUB (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 195-199.

In the case of current Navy Escape Systems, only a limited number of operational modes is available. As an example, a present operational system uses a total of four timing modes to cover the entire ejection cycle. The present paper is concerned with an alternative to the fixed mode selection. A great improvement in system performance is achieved by utilizing currently available microprocessor technology to analyze airspeed and altitude inputs and select from a wide range of programmed operational modes. It is pointed out that this improvement is realized without a sacrifice to system reliability. G.R.

A86-19339
CONTROLLABLE EJECTION SEAT CATAPULT PROGRAM
S. J. BAUMGARTNER (Boeing Military Airplane Co., Seattle, WA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 237-245.

The Controllable Ejection Seat Catapult (CESC) Program is being sponsored by Air Force Wright Aeronautical Laboratories, Flight Dynamics Laboratory, Crew Escape Branch (AFWAL/FIER). The contract was awarded to an American aerospace company on September 16, 1983. An ejection seat catapult has the function to propel the ejection seat out of an aircraft cockpit during emergency ejection conditions. According to the operational performance objective for the catapult, the velocity reached at the end of the catapult stroke is to be maximized without reaching acceleration levels which are harmful to the crewperson. Under certain conditions, the fixed performance capability of the present day catapult becomes unacceptable. The considered program was initiated with the objective to develop a catapult which is free of the drawbacks of the currently used models, taking into account a catapult concept capable of providing a controllable thrust level for a conventional upright ejection seat. G.R.

A86-19573
VERY LARGE STATIONARY AERIAL PLATFORMS
R. S. LEONARD (BDM Corp., Albuquerque, NM) IN: The National Symposium and Workshop on Optical Platforms, Huntsville, AL, June 12-14, 1984, Proceedings . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 446-457. Research supported by the BDM Corp. refs

The development of rigid, semirigid, and nonrigid airships, to operate at altitudes above 40,000 ft for environmental monitoring, ship traffic control, surveillance, and as high altitude observatories is examined. A comparison of airships with aircraft is presented;

the advantages of modern airships are discussed. The materials used for the structure of the airship, which consists of rings, griders, wire bracing, outer skin fabrics, and gas cells, are described. The powering of the airship with electricity from microwave energy is studied. Potential construction sequences which will make the development of the airship economically feasible are analyzed. I.F.

A86-19632*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DIVERGENCE STUDY OF A HIGH-ASPECT RATIO, FORWARD-SWEPT WING
S. R. COLE (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0009)

A study has been conducted in the NASA-Langley Transonic Dynamics wind tunnel to determine the divergence characteristics of a high aspect ratio forward swept wing of rectangular planform, for sweep angles of zero, -15, -30, -45, and -60 deg. In addition to a rectangular wingtip, a tip whose geometry lay parallel with the freestream flow was tested at a sweep angle of -45 deg. The primary objective was to obtain data that could be used to verify the divergence prediction capabilities of an aeroelastic analysis code employing kernel function aerodynamics. The analytical predictions of convergence were found to be conservative for all forward sweep angles, and the effect of the two tip shapes on divergence dynamic pressure were accurately predicted. O.C.

A86-19674#
DESIGN OF A TWIN-ENGINE SHORT-HAUL COMMUTER AIRCRAFT FOR THE 1990S
E. D. COOPER and D. W. MCKENNA (California Polytechnic State University, San Luis Obispo) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. refs
(AIAA PAPER 86-0077)

Taking fuel economy as the primary design criteria for a low direct operating cost (DOC) commuter airliner for the 1990s, a configuration incorporating a 'joined wing' planform and pusher propfans was developed which is projected to yield substantial increases in propulsion efficiency and decreases in weight and drag. The DOC of this design, which is noted to depend on no high risk, novel technologies, was found to be significantly lower than a comparably scaled cantilever wing aircraft. Operating costs were found to be comparable. O.C.

A86-19851*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LABORATORY STUDY OF THE EFFECTS OF SIDEWALL TREATMENT, SOURCE DIRECTIVITY AND TEMPERATURE ON THE INTERIOR NOISE OF A LIGHT AIRCRAFT FUSELAGE
K. E. HEITMAN and J. S. MIXSON (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0390)

This paper describes a laboratory study of add-on {coustic treatments for a twin-engine, propeller-driven aircraft fuselage. The sound source was a pneumatic-driver, with attached horn to simulate propeller noise distribution, powered by a white noise signal. Treatments included a double-wall, production-line treatment and various fiberglass and lead-vinyl treatments. Insertion losses, space-averaged across six interior microphone positions, were used to evaluate the treatments. In addition, the effects of sound source angle and ambient temperature on interior sound pressure level are presented. The sound source angle is shown to have a significant effect on one-third octave band localized sound pressure level. While changes in ambient temperature are shown to have little effect on one-third octave band localized sound pressure level, the change in narrowband localized sound pressure level may be dramatic. Author

A86-19868*# Integrated Systems, Inc., Palo Alto, Calif.
FLIGHT TEST MANEUVER MODELING AND CONTROL
P. K. A. MENON, R. A. WALKER (Integrated Systems, Inc., Palo Alto, CA), and E. L. DUKE (NASA, Flight Research Center, Edwards, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. refs
(Contract NAS2-11877)
(AIAA PAPER 86-0426)

The use of automated flight test schemes decrease the aircraft flight testing time and pilot work load while enhancing the data quality. Two major elements involved in developing such an automated technique are maneuver modeling to generate command histories from the maneuver specifications and the synthesis of control systems to track these command histories. This paper describes the maneuver modeling for eight flight test trajectories. The control system synthesis with Kosut's suboptimal minimum error excitation linear quadratic regulator approach is presented. The closed-loop simulation results are given. Author

A86-19894*# Lockheed-Georgia Co., Marietta.
DEVELOPMENT OF PNEUMATIC THRUST-DEFLECTING POWERED-LIFT SYSTEMS
R. J. ENGLAR (Lockheed-Georgia Co., Marietta), J. H. NICHOLS, JR., M. J. HARRIS (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD), J. C. EPPEL, and M. D. SHOVLIN (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 13 p. refs
(AIAA PAPER 86-0476)

Improvements introduced into the Circulation Control Wing/Upper Surface Blowing (CCW/USB) STOL concept (Harris et al., 1982) are described along with results of the full-scale static ground tests and model-scale wind tunnel investigations. Tests performed on the full-scale pneumatic thrust-deflecting system installed on the NASA QSRA aircraft have demonstrated that, relative to the original baseline configuration, a doubling of incremental thrust deflection due to blowing resulted from improvements that increased the blowing span and momentum, as well as from variations in blowing slot height and geometry of the trailing edge. A CCW/Over the Wing model has been built and tested, which was shown to be equivalent to the CCW/USB system in terms of pneumatic thrust deflection and lift generation, while resolving the problem of cruise thrust loss due to exhaust scrubbing on the wing upper surface. I.S.

A86-19904#
THE BASICS OF ON-BOARD SIMULATION AND EMBEDDED TRAINING
B. J. BRADY (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), R. P. MEYER, R. E. LAMBERT, and C. A. SCOLATTI (McDonnell Aircraft Co., St. Louis, MO) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. refs
(Contract F33615-78-C-3601)
(AIAA PAPER 86-0493)

Embedded training systems (ETS) which use on-board helmet-mounted displays (HMD) to turn fighter aircraft into real-time in-flight simulators are described. A threat situation is presented on the HMD by the ETS computer program and is treated as real by all avionics, thereby joining the features of ground-based simulation and tactical training. The instruments, flight and fire control systems remain active during the encounters with the enemies generated internally. Simulated missiles can be viewed as they fly toward the target(s), which fly programmed tactical maneuvers corresponding to generic enemy aircraft. The realism of the system is enhanced by the presence of actual aerodynamic forces and controls, and the embedded models can even provide radar displays of the visually sighted targets. Trials which will be carried out to evaluate the effectiveness of the ETS are outlined. M.S.K.

A86-19940*# Wichita Univ., Kans.
DESIGNING AN ELECTRO-IMPULSE DE-ICING SYSTEM
G. W. ZUMWALT and R. A. FRIEDBERG (Wichita State University, KS) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(Contract NAG3-284)
(AIAA PAPER 86-0545)

Basic principles and parameters for a system to deice aircraft with electromagnetic impulses are described. The physical basis for deicing by such impulses is explained, and the requirements involved in the electrodynamic design, structural dynamic design, and system design are discussed. Some manufacturing and testing problems and techniques are described. C.D.

A86-19941#
THE ELECTRODYNAMIC OPERATION OF ELECTRO-IMPULSE DEICING SYSTEMS
G. J. LEWIS (Rolls-Royce, Ltd., Derby, England) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. SERC-supported research. refs
(AIAA PAPER 86-0547)

An analysis of the transient exciting current situation is presented. The derivation of the magnetic vector potential equation and its solution using the Laplace and Hankel transforms are described. With the solution of the vector potential equation physical qualities, such as azimuthal force, and impulse, which relate to electro-impulse deicing systems performance are calculated. An experiment measuring the normal impulse on the plate is provided. The dependence of impulse on plate thickness, plate conductivity, plate separation, and discharge frequency is investigated. The theoretical and experimental data show good correlation. An example of an electro-impulse deicing system designed to the specification of the structure being deiced is given. I.F.

A86-20036#
THE DAMAGE TOLERANCE APPROACH IN THE TYPE APPROVAL PROCESS
P. FERNANDEZ-RUIZ (Transport Canada, Airworthiness Branch, Ottawa) (CASI, Annual General Meeting, 31st, Ottawa, Canada, May 28, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 31, March 1985, p. 3-13. refs

The optimization of maintainance procedure for type approval of commercial aircraft is studied. The damage tolerance concept, which is to predict the behavior of aircraft structures under applicable loading conditions, is based on the time it takes for cracks to appear and damage to grow. The time intervals in the maintenance program, threshold inspection level, and repeat inspection interval, are explained. The procedures to be followed by a manufacturer to achieve airworthiness certification of the aircraft are discussed. The selection of materials for design of structures that have high yield, stress, high fracture toughness, and crack growth is examined. The use of load analyses, crack growth models, test data, and numerical integration in the evaluation of aircraft structures is described. The comparison of predicted crack growth values with predefined crack growth and the development of crack growth diagrams for each structure is possible following the analyses. The damage tolerance criteria requires that the aircraft be capable of successfully completing a flight during which structural damage is possible. The testing of the ability of the pressurized fuselage to sustain impact is investigated. I.F.

A86-20038#
HELICOPTER FATIGUE MONITORING USING A SINGLE CHANNEL RECORDER
D. L. SIMPSON (National Aeronautical Establishment, Structures and Materials Laboratory, Ottawa, Canada) (CASI, Annual General Meeting, 31st, Ottawa, Canada, May 28, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 31, March 1985, p. 30-44. refs

The use of single channel recorders and loaded transfer functions to monitor fatigue damage in CH-113 helicopters is investigated. The equipment used includes two single channel recorders for monitoring the output from strain gauges on the longitudinal pitch links on both the fore and aft rotors, and the Rainflow counting method of Hutchinson and Steinman (1980) for data compression. Techniques used to generate transfer functions are analyzed. Identification of the maneuvers which produce cycles that exceed the component endurance limit by applying flight load survey data, and the methods of treating loads above the endurance limit are described. The analyses reveal that conservative estimates of fatigue damage are calculated using transfer functions and the measured longitudinal pitch load spectrum. It is concluded that indirect monitoring of fatigue damage with single channel recorders is possible; however, improvements in instrumentation are required to provide an increase in the percentage of accurate data obtained. I.F.

A86-20039#
ASSESSING COST-EFFECTIVE WEIGHT SAVING IN AIRCRAFT OPERATIONS
D. G. PECK (Transport Canada, Ottawa) (CASI, Annual General Meeting, 31st, Ottawa, Canada, May 28, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 31, March 1985, p. 45-51.

Three methods of establishing cost/weight savings for aircraft are analyzed. The first method described involves measuring the value of the weight by useful load; dividing the points of useful load into the aircraft cost will establish the cost/pound value of the aircraft. A table of values of useful load for various aircraft types is provided. The second technique which calculates the value of weight by the amount of fuel saved is examined; it is observed that jets provide more savings than propeller aircraft and more flight time increases savings. The usefulness of the third method where a value is assigned to weight saving revenue purposes is revealed through an example. I.F.

A86-20125
BIGGER IS BETTER - STRETCHING THE C-141 STARLIFTER
R. A. SAPP (Lockheed-Georgia Co., Marietta, GA) Lockheed Horizons, Oct. 1985, p. 38-44.

A development history is presented for the fuselage-stretching modification undertaken in 1975 for the C-141 cargo aircraft, yielding the C-141B. The fuselage was extended 280 in by inserting a 160-in. plug ahead of the wing, and a 120-in. plug behind it, on an existing C-141A aircraft. In addition, the modification program imparted inflight refueling capabilities, and altered the spanwise wing lift distribution by changing the wing/fuselage fairing structure. The midfuselage structure was reinforced through the addition of a central longeron underneath the cargo floor. Attention is given to the splicing of the plugged fuselage section. O.C.

A86-20155*# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
AEROELASTIC TAILORING - THEORY, PRACTICE, AND PROMISE
M. H. SHIRK, T. J. HERTZ (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH), and T. A. WEISSHAAR (Purdue University, West Lafayette, IN) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 6-18. NASA-supported research. refs
(AIAA PAPER 84-0982)

Aeroelastic tailoring technology is reviewed with reference to the historical background, the underlying theory, current trends, and specific applications. The specific application discussed include the Transonic Aircraft Technology program, an Advanced Design Composite Aircraft, the Wing/Inlet Advanced Development program, and the forward-swept wing. Finally, the future of aeroelastic tailoring and the development of an aeroelastic tailoring analysis and design tool under the Automated Strength-Aeroelastic Design program are examined. V.L.

A86-20157#
BLENDED BLOWN FLAPS AND VECTORED THRUST FOR LOW-SPEED FLIGHT
J. E. CARR (Grumman Aerospace Corp., Bethpage, NY) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 26-31. refs (AIAA PAPER 84-2199)

Short take-off and landing (STOL) capability is a recurring design goal for current and future aircraft design studies to meet reduced field length requirements, provide increased stores 'bring back' capability, enhance carrier aircraft payload launch and recovery envelopes, and improve in-flight maneuvering. The Grumman Corporation has conducted a study to design and build an A-6 STOL demonstrator aircraft for the Navy that employs two-dimensional vectored nozzles and chordwise blowing for low-speed flight. If completed, this program would demonstrate operationally acceptable STOL performance with minimum loss in cruise performance. The results of a two-dimensional airfoil test determined that a plain blown flap with a large-radius, upper leading-edge blowing segment and a conventional-shaped trailing-edge section had better high-lift capability for the available blowing momentum of the design. Extensive three-dimensional wind tunnel testing verified predicted longitudinal characteristics, showed acceptable longitudinal and lateral directional control, and defined design limitations associated with the high-lift systems. Author

A86-20158*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LABORATORY STUDY OF CABIN ACOUSTIC TREATMENTS INSTALLED IN AN AIRCRAFT FUSELAGE
K. E. HEITMAN and J. S. MIXSON (NASA, Langley Reserach Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 32-38. Previously cited in issue 01, p. 4, Accession no. A85-10874. refs

A86-20163#
PERFORMANCE OF A FORWARD SWEPT WING FIGHTER UTILIZING THRUST VECTORING AND REVERSING
E. H. MILLER (Grumman Aerospace Corp., Bethpage, NY) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 68-75. Previously cited in issue 23, p. 3404, Accession no. A83-48344. refs (Contract MDA903-82-C-0218)

A86-20165#
FINITE ELEMENT ANALYSIS OF AN ULTRALIGHT AIRCRAFT
T. V. BAUGHN and P. F. PACKMAN (Southern Methodist University, Dallas, TX) (Structures, Structural Dynamics, and Materials Conference, 26th, Orlando, FI, April 15-17, 1985, Technical Papers. Part 1, p. 71-78) Journal of Aircraft (ISSN 0021-8669), vol. 23, Jan. 1986, p. 82-86. Previously cited in issue 13, p. 1848, Accession no. A85-30234.

A86-20235#
ENDURANCE INCREASE BY CYCLIC CONTROL
G. SACHS and T. CHRISTODOULOU (Muenchen, Technische Universitaet, Munich, West Germany) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Jan.-Feb. 1986, p. 58-63. refs

Applying the minimum principle, maximum endurance flight is considered as an optimal cyclic control problem with a state variable constraint. It is shown that a significant increase in the maximum endurance can be achieved by dynamic flight having an optimal cyclic control when compared to the best steady-state flight. The optimal altitude range within the flight envelope is determined. Furthermore, it is shown that the powerplant type represents a key factor when compared to other aircraft characteristics. From this, it follows that turbojet-type engines have properties that can increase endurance via cyclic control. With regard to propeller-type powerplants, however, there appears to be no or only small improvements possible for the cyclic model considered here. It is also shown that an increase in the maximum lift/drag ratio improves the cyclic control efficiency, which is more enhanced than steady-state flight efficiency. Author

A86-20238*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
SIMULATOR EVALUATION OF A REMOTELY PILOTED VEHICLE VISUAL LANDING TASK
S. K. SARRAFIAN (NASA, Flight Research Center, Edwards, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Jan.-Feb. 1986, p. 80-84. Previously cited in issue 20, p. 2851, Accession no. A84-42348. refs

A86-20822
ELIMINATION OF BUFFETING ON THE REAR FUSELAGE OF THE HERCULES TANKER
D. G. MABEY (Royal Aircraft Establishment, Dynamics Laboratory, Bedford, England) Aeronautical Journal (ISSN 0001-9240), vol. 89, Nov. 1985, p. 339-342.

The conversion of the Hercules aircraft for flight refuelling necessitated the installation of a small drogue box on the lower surface of the rear fuselage. This produced a long flow separation and unacceptable rear fuselage and elevator buffeting at the drogue towing speeds required. The flow separation was stabilized, and the buffeting eliminated, by the installation of strakes and the provision of a small bleed flow through the drogue box. Author

A86-20932
GEOMETRY GENERATION FOR TRANSONIC DESIGN
H. SOBIECZKY (DFVLR, Institut fuer theoretische Stroemungsmechanik, Goettingen, West Germany) IN: Advances in computational transonics . Swansea, Wales, Pineridge Press, 1985, p. 163-182. USAF-sponsored research. refs

Since demands for higher efficiency and improved performance have led to the operation of aircraft in the transonic regime, computational design procedures for both aircraft and turbomachinery have become increasingly important. The designed aircraft components have to be integrated into realistic configurations, and wind tunnel tests and refined investigations are required to predict aerodynamic performance reliably. As a result of the need of refined shape definition, the generation of geometry has become an important part of computational aerodynamics. The present paper is concerned with a flexible geometry generator which is based on a set of parameters and analytical relations. The geometry generator is to provide input data for a number of existing transonic analysis algorithms and some shock-free flow design codes. Aspects of shape generation are discussed, taking into account simple analytical relations, a fuselage geometry definition, a wing geometry definition, and wing integration to fuselage. Attention is also given to airfoil design and analysis, and computational grid generation. G.R.

A86-21051
SOCIETY OF EXPERIMENTAL TEST PILOTS, SYMPOSIUM, 28TH, BEVERLY HILLS, CA, SEPTEMBER 26-29, 1984, PROCEEDINGS
Lancaster, CA, Society of Experimental Test Pilots, 1984, 321 p. For individual items see A86-21052 to A86-21054, A86-21056 to A86-21068.

Papers are presented on supersonic conventional weapon testing, F-14A low-altitude, low-airspeed, high-angle-of-attack asymmetric thrust flight test program, initial sea trials of the AV-8B Harrier aircraft, flight tests of the helicopter pneumatic deicing system, and testing the modern composite scaled prototype. Consideration is given to F/A-18 ski jump takeoff evaluation, nonrigid airship testing, helicopter evasive maneuvering flight test, testing Canadian unique features of the CF-18, AV-8B Harrier II structural test program, probe and drogue refueling large receiver aircraft, and high speed escape systems. In addition, flight testing the fixed wing configuration of the rotor systems research aircraft, F-15 dual-role fighter flight testing, Space Shuttle development update, Space Shuttle night landing, and orbital flight test of the manned maneuvering unit are discussed. I.S.

A86-21052
SUPERSONIC CONVENTIONAL WEAPON TESTING OF THE F/A-18A HORNET
J. C. STENCIL and J. PICKERAL (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 4-16.

The F/A-18A Hornet is the Navy's first tactical airplane to provide supersonic carriage and release of conventional weapons. In the course of an extensive weapon separation analysis and flight tests, the envelope expansion has uncovered interesting integration phenomena, some related to the aircraft, and some related to existing weapons hardware. The combination of an airplane with the performance capability for supersonic carriage and delivery and the extensive use of composite materials in its construction presented unique test and evaluation challenges. This paper discusses limit cycle oscillations of the wing under certain store loadings, supersonic conventional weapon separation testing of general purpose weapons, and hardware deficiencies which potentially have serious impact on the aircraft tactical envelope. The need to improve conventional weapons for the new generation of supersonic strike fighters is emphasized. Author

A86-21053
F-14A LOW ALTITUDE, LOW AIRSPEED, HIGH ANGLE OF ATTACK ASYMMETRIC THRUST FLIGHT TEST PROGRAM
C. M. BAUCOM and C. CLARK (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 17-26.

The effect of asymmetric thrust (AT), due to single engine failure during low-speed, high-angle-of-attack (AOA) maneuvering, on F-14A high AOA flying qualities have been tested at low altitudes, using a F-14A No. IX highly modified aircraft with numerous special installations. Real-time F-14 simulation models, updated aerodynamic models for both the clean and external stores configurations, and a new TF30-P414A thrust model were implemented, and several low-speed aerodynamic coefficients were modified on the basis of previous flight-test results. In addition to the structured maneuvers, the effects of thrust asymmetry from both afterburner failure and full engine stalls while performing tactical fleet fighter maneuvers were tested. While AT alone did not produce disorienting departures, flight control departures could be easily induced when the uncommanded roll from thrust asymmetry was countered by natural sense lateral stick inputs away from roll. The AT contribution to such combined AT/flight control departures was the major cause of the subsequent yaw accelerations only at very high AOAs. I.S.

A86-21054
AV-8B INITIAL SEA TRIALS
M. A. NYALKO and R. E. GRIMES (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 27-38.

Shored-based buildup tests, a laboratory simulation, and shipboard tests were conducted to evaluate the capabilities of the AV-8B aircraft model to operate from air-capable amphibious ships, and to compare these capabilities to those of the AV-8A aircraft. The aspects of the shipboard takeoff and landing performance, the launch and recovery techniques, the aircraft/ship interface, and the instrument approach profiles and procedures were investigated. All tests were conducted in the V/STOL configuration with gear down, ailerons dropped 15 deg, and flaps and nozzles interconnected. The tests have demonstrated an excellent capability of AV-8B to operate from a sea-based platform, with the STO performance gains of up to 42 percent increased over the AV-8A in mission payload, and an improvement of flying qualities in all flight regimes, resulting in greatly reduced pilot workload. Crosswind takeoff limitations were influenced entirely by ship's effects and were the same as those of the AV-8A. Approach profile testing to a 0.5 NM minimum showed that the AV-8B will be able to operate in all-weather conditions. I.S.

A86-21056
PROGRESS REPORT - F-16 C&D TESTING
K. DWYER (General Dynamics Corp., Fort Worth, TX) and T. MESCHKO (USAF, Edwards AFB, CA) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 58-71.

The goals and some results of a three-stage F-16 Multinational Staged Improvement Program (MSIP) for the continued expansion of the F-16A/B aircraft capabilities are presented. As the ultimate goal, the future F-16C/D aircraft under development is intended to perform both the night, low-level, ground-attack missions and the all-weather, multi-target, air-to-air missions. Improved cockpit, new and improved avionics, airframe changes, and added weapon carriage are the major changes introduced during Stages I and II of the F-16 MSIP. The following systems are planned for incorporation into the F-16C/D aircraft during Stage III: the Low-Altitude Navigation and Targeting Infrared for Night system, which incorporates navigation and targeting forward looking infrared sensors and a terrain-following radar; the Advanced Medium-Range Air-to-Air Missile, as the beyond-visual-range weapon; the F-110 GE-100 engine; ASPJ equipment; the ALR-74 Radar Warning Set; the Global Positioning System; and the Precision Locator Strike System. I.S.

A86-21057
F-20A TIGERSHARK PROGRESS REPORT
D. BARNES (Northrop Corp., Los Angeles, CA) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 75-100.

The progress of the F-20 flight test and marketing support efforts and of the basic F-20 design is reported. Three main topics are covered: (1) the aircraft characteristics, in particular the recently changed features, (2) selected recent flight test results, and (3) the customer demonstration and marketing-support activities. Among the special characteristics of the F-20A aircraft are an increased wing and flap area, an upgraded 18,000-lb production engine, integrated digital avionics, a first-flight-test instrument panel (FTIP) with a programmable digital display, and the second- and third-FTIP for avionics testing. The results of testing the airworthiness, the performance and flight qualities, and flight avionics performed in more than 910 test flights have verified the high degree of reliability, maintainability, and safety of the F-20A Tigershark aircraft. I.S.

A86-21058
CONVENTIONAL TAKEOFF AND LANDING (CTOL) AIRPLANE SKI JUMP EVALUATION
C. P. SENN and T. A. WAGNER (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 101-117.

Ski-jump launching as an alternative to shipboard catapult launch for conventional takeoff and landing (CTOL) aircraft was evaluated by tests on an F/A-18A aircraft, using a pitch attitude-capture flyaway technique. Results of ground acceleration runs and high-angle-of-attack tests, dynamic single-engine flight characteristics, and definitions of aborted takeoff/committed to takeoff criteria are reported. In a total of 91 ski-jump launches, operated from both the 6 and 9 deg ramp, about 66 percent reduction in takeoff ground roll was obtained, compared to the normal ground takeoff. A ski-jump launch is an easier maneuver than a normal field takeoff. Any operational CTOL ski-jump aircraft should have a Head-Up Display, nosewheel steering, stability augmentation in all axes, and an accurate, repeatable flight control trim system. The general arrangement and dimensions of the test ski-jump equipment are included. I.S.

A86-21059
NON-RIGID AIRSHIP TESTING
L. D. WHITMER and K. BEEKS IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 118-127.

The flying qualities and performance of a lighter-than-air aircraft, the Patrol Airship Concept Evaluation (PACE) test airship, designated AI-500, were evaluated. NASA's Ames, in conjunction with Systems Technology, provided the instrumentation for dynamic tests and propeller thrust measurements. The results indicate that the AI-500 has a potential for use in maritime patrol missions. However, the conventional control system is inadequate for long-endurance or heavy-weather missions due to high control forces in maneuvering flight, and a requirement for the pilot to continually monitor the controls to maintain proper altitude and heading alignment. The vectored thrust did provide a VTOL capability, but not an adequate rearward vector angle and lateral control in the hovering environment. An analysis indicated that these deficiencies were correctable. I.S.

A86-21060
TESTING CANADIAN UNIQUE FEATURES OF THE CF-18 - THE FIRST YEAR
G. M. LACROIX (Aerospace Engineering Test Establishment, Canada) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 150-163.

The initial Weapons Clearing Program (WCP) of Canada's multirole CF-18 fighter was tested, including the 19 tube LAU-5003 rocket launcher and 2.75-in. CRV-7, the BL-755 cluster bomb, and the SUU-5003 training dispenser with four CRV-7's and six Modular Practice Bombs. The major program phases consisted of the flutter, flying qualities, cruise performance, the separation/jettison, and the rocket compatibility/accuracy tests. The results indicate that all objectives of the CF-18 initial WCP were achieved. Appropriate limits have been established to ensure the successful employment of the WCP weapons, and the follow-on testing has been identified to further enhance the capabilities of the CF-18. Diagrams of the CF-18 flutter test configurations, flying qualities test configurations, and the flutter analysis system are included. I.S.

A86-21061
STRUCTURAL DEMONSTRATION OF THE AV-8B HARRIER II
J. C. JACKSON (McDonnell Aircraft Co., St. Louis, MO) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 164-175.

Structural demonstration of the AV-8B Harrier II, an aircraft that is 26 percent advanced composite material (graphite material filaments bonded together in a matrix of epoxy), and the results of the ground- and flying-tests are presented. The ground fatigue tests on the airframe had no failures, and the parts of the aircraft made from composite materials did extremely well. Five different configurations were tested in the flight test program, ranging from a clean aircraft to one carrying four 1000-lb bombs. The low-altitude and high-speed handling qualities of the aircraft were satisfactory. There were no major structural failures encountered nor load limits exceeded. A unique method of instrumentation was developed for this aircraft, in which the measurands were sandwiched in between layers of the composite materials as they were put together. The diagrams of the AV-8B aircraft, its control surface loads instrumentation, the test site communication system, as well as the structural demonstration points are included. I.S.

A86-21062
PROBE AND DROGUE REFUELLING LARGE RECEIVER AIRCRAFT
J. A. BROWN (Aeroplane and Armament Experimental Establishment, Boscombe Down, England) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 176-190.

The probe- and-drogue refueling techniques of large fighter-type aircraft, practiced in the 1950's and 1960's and applied again during the Falklands' crisis, are reviewed. The trials method involved and the problems of performance (in particular, in cases when the envelope overlap is small, and the refueling must take place at altitudes below 10,000 ft, where the worst of the weather is found) are discussed in detail. Special attention is given to the aspects of handling a large receiver and the problems connected with pilot-induced oscillations and heavy controls (heavy ailerons, elevators, etc.) in the situations where lateral position must be controlled within 9 inches with minimal lateral motion at the time of contact. The effect of receiver's bow wave on the drogue is considered. Finally, the potential dangers of propellers in the C2, Transall, and C130 probe and drogue receivers are examined. A list of recommendations is given concerning characteristics and features of an ideal probe-and-drogue large receiver vehicle. I.S.

A86-21063
ESCAPE SYSTEMS TESTING
J. B. MCDONALD and D. GRAGG (USAF, Holloman AFB, NM) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 191-206. refs

The escape system's (ES's) aspects of flight testing, in particular the problems encountered in the dynamic speed ranges above 600 KEAS, are presented. The development history of ES in the last 20 years led to the introduction of an encapsulated ES and the new Advanced Concept Ejection Seat (ACES)-II. Problems posed to the ESs by helicopter blades are considered. Special problems involved in high-speed escape (up to 700 KEAS), where human tolerance may be exceeded due to the explosive catapult charge, windblast, and acceleration, resulting in disabling spine injuries, are discussed. A new generation of ejection seats, introduced by an advanced development program, the Crew Escape Technology (CREST), is examined. The CREST seats will enable a safe escape at 700 KEAS, needing only 75 ft at 300 KEAS and a flight path angle of 30 deg, and will have advantageous restraining capability. In addition, a new concept in sled design, the Multi-Axis Seat Ejection Sled, is discussed. I.S.

A86-21064* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLIGHT TESTING THE FIXED WING CONFIGURATION OF THE ROTOR SYSTEMS RESEARCH AIRCRAFT (RSRA)
G. W. HALL (NASA, Ames Research Center, Moffett Field, CA) and P. M. MORRIS (U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 209-223. Previously announced in STAR as N85-34135.

The Rotor Systems Research Aircraft (RSRA) is a unique research aircraft designed to flight test advanced helicopter rotor system. Its principal flight test configuration is as a compound helicopter. The fixed wing configuration of the RSRA was primarily considered an energy fly-home mode in the event it became necessary to sever an unstable rotor system in flight. While it had always been planned to flight test the fixed wing configuraion, the selection of the RSRA as the flight test bed for the x-wing rotor accelerated this schedule. This paper discusses the build-up to, and the test of, the RSRA fixed wing configuration. It is written primarily from the test pilot's perspective. Author

A86-21065
F-15 DUAL-ROLE FIGHTER FLIGHT TESTING
D. C. SPENCER (USAF, Flight Test Center, Edwards AFB, CA) IN: Society of Experimental Test Pilots, Symposium, 28th, Beverly Hills, CA, September 26-28, 1984, Proceedings . Lancaster, CA, Society of Experimental Test Pilots, 1984, p. 224-236.

A development test and evaluation effort on the F-15E Dual-Role Fighter (DRF) is reported. The F-15E, which as a derivative of the current F-15 aircraft, is a projected long-range aircraft for the air-to-ground (A/G) as well as the air-to-air (A/A) missions. The aspects of the F-15 derivative (equipped with Conformal Fuel Tanks and five-station weapon carriage), fighter evaluation, the scope of the testing, the performance results, specific flying qualities, and avionics evaluation are discussed. The improvements planned for the F-15E include an upgraded radar, programmable armament control set, and Advanced Medium-Range A/A Missile capability, as well as Low Altitude Navigation Infrared System for Night pods, HRR equipment, and expanded weapons capability. The crew station design has been reconfigured, to incorporate the state-of-the-art avionics, and tested successfully by a high-fidelity flight simulator. The flight tests have demonstrated that the F-15E DRF, while retaining the superior A/A capability of the F-15, will be capable of the deep strike/interdiction missions at night and/or under the weather. I.S.

A86-21306
BASIC AIRCRAFT PERFORMANCE
S. A. POWERS (Fairchild Republic Co., Conceptual Systems Development Directorate, Farmingdale, NY) Duxbury, MA, Kern International, Inc., 1984, 238 p.

A set of eight computer programs which can be used to generate accurate estimates of the performance of aircraft, both on prescribed missions and in maneuvering flight at prescribed conditions, is described. A sophisticated, state of the art drag prediction method, a thrust/fuel flow input and evaluation program, and a simple method of describing complex missions are included in the set of programs. With this computing system, it is possible to go from a three view drawing of an aircraft and a table of thrust/fuel flow data for the engine to a completed performance envelope and a mission performance description in two hours elapsed time. The use of each program is discussed, and an example of the use of each option is provided. The methods used in the programs are described, and each variable used is identified. C.D.

A86-21712
SF-340 AIRFOIL STRUCTURE - A UNIQUE APPROACH
P. V. OLIVA (Fairchild Republic Corp., Farmingdale, NY) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 116-124.

The major effort was directed at the fabrication process development for a generic aileron. Full size feasibility structural shells were produced and used to develop efficient fabrication techniques. These were utilized in the successful production of a generic monocoque shell. A complete aileron assembly was produced by installing hinge fittings and end ribs to the shell and the structure was subjected to static test. No discernible damage was detected at 150 percent of design ultimate load (225 percent of limit load) and the strain values were in excellent agreement with prediction. The hollow shell structure, which consists of an inner and outer graphite/epoxy face sheets sandwiched on a Nomex honeycomb core is shown. This new unique approach for an all composite aileron is currently in production on the commercial aircraft designated as the SF-340. Author

A86-21897#
DESIGNING AN AIRLIFTER - MCDONNELL DOUGLAS'S C-17
R. DEMEIS Aerospace America (ISSN 0740-722X), vol. 24, Jan. 1986, p. 66-68, 70.

A design development history is presented for the C-17 military airlifter, whose performance requirements have been characterized as a synthesis of the external dimensions of the C-141B, the cargo capacity of the C-5, and the short/soft airfield operations capabilities of the C-130. Emphasis is given to the ground handling features of the C-17, whose cargo ramp can bear as great a load as the payload volume's main floor. Powered lift for STOL is effected through the direction of the four engines' exhausts onto the extended, double slotted flaps. Low life cycle costs were paramount in the course of C-17 design; for the first time, a military aircraft will be covered by warranties for reliability, maintainability, and mission completion. O.C.

A86-22098#
F-14 RE-ENGINING WITH THE F110 ENGINE
O. T. CASTELLS (General Electric Co., Evendale, OH) and J. T. STRONG, JR. (Grumman Aerospace Corp., Bethpage, NY) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 8 p.
(ASME PAPER 85-GT-184)

The advantages of re-engining the F-14 aircraft with the F110 engine is presented. The areas of improvement and the engine development philosophy are explained. A summary description of the pertinent engine design features of the F110 are presented. The flight test results on inlet/engine compatibility, afterburner operation, airplane performance, and maintainability/reliability/durability are interpreted. Finally, a description of the proposed version of the F110 engine for the F-14 is presented. Author

A86-22112#
THE KC-135/CFM56 RE-ENGINE PROGRAM
P. H. PACKER and M. P. GOODMAN (Boeing Military Airplane Co., Wichita, KS) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 6 p. refs
(ASME PAPER 85-GT-211)

This paper reviews the preliminary studies that led to the KC-135/CFM56 Re-Engine Program and discusses the motivation for re-engining an aircraft, designed in the mid 1950s, with a modern high bypass turbofan. The selected engine, the CFM56-2B-1. The other major aircraft modifications are described. The KC-135R test program methods and results are addressed with particular attention given to engine and aircraft performance. The overall benefits of the program relating to mission capability, environmental impact, and cost are also presented. Author

A86-22127#
THE F-16 COMMON ENGINE BAY
C. E. PORCHER ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 8 p.
(ASME PAPER 85-GT-231)

The aircraft-engine interfaces of the F-16 fighter's Common Engine Bay (CEB) are compatible with the current F100-PW-200 engine or either of the F110-GE-100 and F100-PW-220 engines of the U.S. Air Force's Alternate Fighter Engine competition. Simple kits allow changes among any of these three engines to be made in the field. Attention is presently given to the concept development history and program management aspects of the CEB, as well as the design features and control requirements of engine installation. O.C.

A86-22131#
XB-70 STRUCTURES AND MATERIALS ADVANCEMENTS
L. M. LACKMAN (Rockwell International Corp., El Segundo, CA) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 3-1 to 3-13. refs

The XB-70 was developed in the late 1950's. It was designed for intercontinental range at a sustained Mach 3 flight velocity while flying at an operational altitude of 70,000 feet. This environment required the establishment of many new criteria for structural design. Demanding and expansive structures/materials developments were vital in attaining the design goals. The structural configuration employed and its analysis and testing is presented.

The development of brazed steel honeycomb sandwich for use in shells and wing structures is described. New corrosion-resistant steel and titanium alloys were developed and are reviewed. The application of welded butt joints in steel honeycomb is discussed. The contributions of the XB-70 to the structural design of the following generation of high-speed aircraft are covered. Author

A86-22132#
STRUCTURAL EVOLUTION B-58 TO F-16
E. M. PETRUSHKA and J. W. MORROW (General Dynamics Corp., Fort Worth, TX) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 4-1 to 4-6.

The evolution from the B-58 'bonded bomber', where extreme emphasis was placed on structural performance, to the F-16 aircraft, based on the USAF Aircraft Structural Integrity program philosophy, is described. A transitional stage between these two aircraft designs is represented by the F-111, which utilized high-strength materials and bonded structure technology and in which the original steel design as augmented with a boron doubler, which reduced stress levels in wing pivot fittings. The F-16 is the first USAF aircraft to be designed, from the start, to meet durability and damage tolerance requirements under the acceptance methods of MIL-STD-1530A. The paper includes structure diagrams and design specifications of F-16 aircraft features. I.S.

A86-22133#
STARSHIP 1
E. H. HOOPER (Beech Aircraft Corp., Wichita, KS) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 6-1 to 6-6.

The application of advanced composite materials in the construction of the Beechcraft Starship I is reviewed. The material systems utilized are described as are the specific structural concepts for typical airframe components. The paper discusses the manufacturing processes briefly. Author

A86-22165#
A CASE STUDY IN FATIGUE LIFE EXTENSION - THE MAIN SPAR OF RAAF MIRAGE IIIO WINGS
J. Y. MANN (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) and K. J. KENNEDY (Commenwealth Aircraft Corp., Ltd., Melbourne, Australia) Institution of Engineers , Mechanical Engineering Transactions (ISSN 0727-7369), vol. ME10, July 1985, p. 90-97. refs

The operation of the Australian and Swiss Air Forces' Mirage III aircraft beyond their original fatigue design or certification lives, without increasing the risk of structural failure, prompted a fatigue life extension program whose task was complicated by the discovery of fatigue cracks at the bolt holes of the wings' main spar. A comprehensive fatigue testing program was undertaken to extend the wings' service life on the basis of interference-fit bushes. The net cost savings of this program, which extended to inspection, manufacturing and installation procedures, represented savings of about $19 million Australian by comparison with the alternative of purchase of new wings from the manufacturer. O.C.

A86-22261
CANARD MIRAGE ON TEST
W. SPYCHIGER (Swiss Defence Technology and Procurement Agency, Switzerland) Flight International (ISSN 0015-3710), vol. 128, Dec. 14, 1985, p. 38-40.

A flight test program is being conducted by the Swiss Air Force to determine whether nose strake/canard control surface additions to its fleet of Mirage IIIs are a cost-effective means of extending high angle of attack maneuverability, and therefore of allowing retention of the Mirage III through the 1990s. Attention is given to gun firing certification test results for aircraft of this type with and without canards and strakes, as well as to experience with Sidewinder missile separation tests. A small canard is used which requires no airframe structural modification. Low speed maneuverability and instantaneous turn rate are significantly improved by canards. O.C.

A86-22262
OLD FIGHTERS - NEW TARGETS
J. H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 6, Jan. 1986, p. 4-8.

Full scale target drones derived from mothballed combat aircraft by means of a conversion program that furnishes continuous remote control, destruct, smoke emission visual acquisition and target scoring systems provide the most realistic training of combat pilots for confrontation with prospective threats. F-86, T-33, and F-104 single seat aircraft, as well as B-47 bombers, have been employed in this capacity. Attention is presently given to the conversion process to which F-100 fighters are subjected, and their remote control system's architecture. O.C.

A86-22263
EXPLORING THE UNKNOWN WITH UNMANNED AIRCRAFT
J. H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 6, Jan. 1986, p. 22-27.

An evaluation is made of the operational and economic rationales for the use of remotely piloted research vehicles (RPRVs) in the study of novel aerodynamaic configurations and flight control techniques. These 'undersize' aircraft can be manufactured for a fraction of the cost of a full sized, piloted research vehicle, and can be used to obtain high quality flight test data in extreme portions of the given flight envelope without endangering a test pilot. High-G maneuvering beyong the limits of human tolerance can therefore be routinely studied by an RPRV such as the Highly Maneuverable Aircraft Technology vehicle. Spin phenomenon research and oblique wing RPRVs have also been successfully employed. O.C.

A86-22378
AV-8B DESIGN FOR MAINTAINABILITY
R. J. ANDERSON (McDonnell Aircraft Co., St. Louis, MO) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 28-33.

Methods, procedures, and design features used to create a maintainable and effective AV-8B light attack Vertical/Short Takeoff and Landing (V/STOL) aircraft for operations from all classes of carriers, VTOL ships/sea platforms, shore bases, and forward sites are identified. A comparison with AV-8A, stressing areas of improvement, is made. The AV-8B maintainability requirements are given along with the highlights of efforts to meet those requirements. The use of high yield technology in the AV-8B is discussed, as are improvements in structure, the landing gear system, the fuel system, and the armament system. The results of Maintenance Engineering Inspection and of Full Scale Development Evaluation are described. C.D.

A86-22400
F/A-18 HORNET - RELIABILITY DEVELOPMENT TESTING
W. R. ROGGER (McDonnell Aircraft Co., St. Louis, MO) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 373-378.

The F/A-18 reliability program established reliability development testing (RDT) as a firm requirement. The F/A-18 dedicated RDT had the objective to improve future hardware reliability by timely identification of problems and verification of corrective actions. The Operational Mission Environment (OME) was converted to extreme conditions during RDT to accelerate failure mechanisms without inducing nonrepresentative failure modes. It is pointed out that the original F/A-18 requirements specified that reliability development tests for avionics be conducted on all customer furnished equipment (CFE). Attention is given to details regarding the F/A-18 Avionic Equipment Reliability Test, OME study results, test environments, application to preplanned product improvement, and lessons learned in connection with the F/A-18 RDT. G.R.

N86-16211# National Aerospace Lab., Amsterdam (Netherlands). Hoofdafd. Stromingen.
FATIGUE LIFE MONITORING OF AIRCRAFT
J. B. DEJONGE 27 Oct. 1983 10 p In DUTCH; ENGLISH summary Presented at Netherlands Association of Aeronautical Engineers, 1 Dec. 1983
(NLR-MP-83069-U; B8568105) Avail: NTIS HC A02/MF A01

Methods for monitoring fatigue loads on aircraft structures are presented. As the actual service life deviates appreciably from design load spectrum assumptions, a reassessment of safe service life and inspection schedules are shown to be necessary. Simple counting accelerometer systems; multiparameter recording systems; and direct strain monitoring systems are discussed. Examples of combat aircraft and civil transport aircraft are presented. The interpretation of recorded loads in terms of accumulated fatigue damage is considered. Author (ESA)

N86-16653# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
AIRWORTHINESS FLIGHT TEST PROGRAM OF AN AIRCRAFT EQUIPMENT FAIRING
V. R. MILLER and T. P. SEVERYN (4950th Test Wing, Wright-Patterson AFB, Ohio) *In* Shock and Vibration Information Center The Shock and Vibration Bulletin 55, Part 2 p 69-75 Jun. 1985 refs
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 01C

The results of an airworthiness flight test program of an aircraft equipment fairing are given. The objective of the tests was to insure the airworthiness of the aircraft with the installed fairing. The tests were conducted to determine the structural integrity of the modifications and their effects on the aircraft handling qualities. The tests were extended to allow more detailed data acquisition and analysis due to the problems encountered with flow separation, aerodynamic buffeting and noise-induced fatigue. The test indicated that the airspeed envelope of the aircraft be restricted while the fairing was installed, and that structural modifications to portions of the aircraft be made. Rigid inspection requirements were levied after each flight to detect any structural damage. Author

N86-17297# Fuji Heavy Industries Ltd., Utsunomiya (Japan).
APPLICATION OF COMPUTATIONAL AERODYNAMICS TO WING DESIGN
M. MAKADATE *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 271-278 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

Recent progress in Computational Aerodynamics has enabled the engineers of aircraft manufacturers to utilize transonic aerodynamic analysis programs in designing wings. Effectiveness of control surfaces (spoiler, aileron), which is greatly influenced by the characteristics of the wing, is an important problem. This paper introduces application of transonic aerodynamic analysis programs to the computation of control surface effectiveness. B.W.

N86-17298# National Aerospace Lab., Tokyo (Japan).
A NUMERICAL SOLUTION OF THE TRANSONIC INTEGRAL EQUATION AND ITS APPLICATION TO THREE-DIMENSIONAL TRANSONIC WING DESIGN
S. TAKANASHI *In its* Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 279-292 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

A numerical solution of the transonic integral equations is presented for three-dimensional transonic wing design. The objective of the design problem is to determine the wing geometry which realizes a prescribed pressure distribution on the wing surface. This boundary value problem can be formulated by the transonic integral equations with artificial viscosity terms. The resulting integral equations are simplified by introducing an approximate function for the space velocity distribution which reduces the three-dimensional problem to a two-dimensional one. The uniqueness of solution is guaranteed by imposing an additional condition, i.e., the closure condition at the trailing edge. To facilitate numerical evaluation of the definite integrals the wing surface is divided into a number of small rectangular panels. As a result, the singular integral equations are converted to a system of linear equations which can easily be solved by standard numerical techniques. An extension of the integral equation method to more general and versatile design procedure is described, and some of the design results for a transonic sweptback wing with an isobar pattern are also presented. Author

N86-17299# Mitsubishi Heavy-Industries Ltd., Tokyo (Japan).
A WING DESIGN BASED ON THE THREE-DIMENSIONAL TRANSONIC INVERSE METHOD AND THE COMPARISON WITH THE WIND TUNNEL TESTING DATA
S. TATSUMI and S. TAKANASHI *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 293-304 1984 refs In JAPANESE; ENGLISH summary
Avail: NTIS HC A14/MF A01

Along with the recent progress in computational aerodynamics, aircraft designers have paid great attention to inverse methods. Inverse methods, which determine wing geometries under prescribed target pressure distributions, are considered important design techniques because of the applicabilities of experience and knowledge of aircraft designers. Although several two-dimensional methods have already been established, there exist only a few reports about three-dimensional transonic inverse methods, and the three-dimensional technique has not been established yet. This report describes wing design by the three-dimensional transonic inverse method using the integral equation formulation which was developed by one of the authors. The method has the great advantage that various flow-solvers can be applied. Also wind tunnel testing was conducted with the design wing to investigate the capability of the method. The comparison of design and test results shows a good agreement and the method proves to be very effective in three-dimensional transonic wind design. Author

N86-17336 Royal Aircraft Establishment, Farnborough (England).
STANDARDISED FATIGUE LOADING SEQUENCES FOR HELICOPTER ROTORS (HELIX AND FELIX). PART 1: BACKGROUND AND FATIGUE EVALUATION
P. R. EDWARDS, comp. and J. DARTS, comp. 14 Aug. 1984 115 p refs 2 Vol.
(RAE-TR-84084; RAE-MAT/STRUCT-101-PT-1; ICAF-1442-PT-1; NLR-TR-84043-U-PT-1; LBF-FB-167-PT-1; IABG-TF-1425-PT-1; BR95787) Avail: NTIS HC A06/MF A01

The background of the Helix and Felix standard loading sequences for the main rotors of helicopters with articulated and semirigid rotors respectively is outlined. The loading standards provide a convenient tool for providing fatigue data under realistic loading, which can immediately be compared with other data, and can be used to provide design data. Helix and Felix statistical content according to different counting methods and the results of fatigue tests used to assess them are presented. Author (ESA)

N86-17337 Royal Aircraft Establishment, Farnborough (England).
STANDARDISED FATIGUE LOADING SEQUENCES FOR HELICOPTER ROTORS (HELIX AND FELIX). PART 2: FINAL DEFINITION OF HELIX AND FELIX
P. R. EDWARDS, comp. and J. DARTS, comp. 14 Aug. 1984 122 p refs 2 Vol.
(RAE-TR-84085; RAE-MAT/STRUCT-100-PT-2; ICAF-1442-PT-2; NLR-TR-84043-U-PT-2; LBF-FB-167-PT-2; IABG-TF-1425-PT-2; BR95846) Avail: NTIS HC A06/MF A01

Full length and shortened versions of the Helix and Felix standard loading sequences for rotors of helicopters with articulated and semirigid rotors respectively are presented. The standards provide a convenient tool for providing fatigue data under realistic

loading, which can immediately be compared with other data, and can be used to provide design data. The method of generation is extremely simple, although a considerable amount of data is required for the generation algorithm. A FORTRAN program and complete data tables in the correct format are given.
Author (ESA)

N86-17338*# National Aeronautics and Space Administration, Washington, D.C.
AERODYNAMIC DESIGN TRENDS FOR COMMERCIAL AIRCRAFT
R. HILBIG and H. KOERNER Jan. 1986 54 p refs Transl. into ENGLISH of conference paper "Aerodynamische Entwicklungsrichtungen fuer Verkehrsflugzeuge" rept. DGLR-84-082 presented at the German Aerospace Society Annual Convention, 1984 p 1-53 Convention held in Hamburg, West Germany, 1-3 Oct. 1984 Original language document was announced in IAA as A85-40302 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASW-4004)
(NASA-TM-77976; NAS 1.15:77976) Avail: NTIS HC A04/MF A01 CSCL 01C

Recent research on advanced-configuration commercial aircraft at DFVLR is surveyed, with a focus on aerodynamic approaches to improved performance. Topics examined include transonic wings with variable camber or shock/boundary-layer control, wings with reduced friction drag or laminarized flow, prop-fan propulsion, and unusual configurations or wing profiles. Drawings, diagrams, and graphs of predicted performance are provided, and the need for extensive development efforts using powerful computer facilities, high-speed and low-speed wind tunnels, and flight tests of models (mounted on specially designed carrier aircraft) is indicated. T.K.

N86-17340# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique de la Resistance des Structures.
CRITICAL ANALYSIS OF TURBULENCE RESTITUTION FROM ACCELERATION MEASUREMENTS [ANALYSE CRITIQUE DE LA RESTITUTION DE LA TURBULENCE A PARTIR DE MESURES D'ACCELERATION]
G. COUPRY Jan. 1985 34 p refs In FRENCH
(Contract STPA-84-95015)
(ONERA-RT-3/3567-RY-C40-R) Avail: NTIS HC A03/MF A01

Civil aircraft acceleration data were collected for an atmospheric turbulence data bank. Differences observed among the different types of aircraft are analyzed. The error analysis shows that these differences are not related to turbulence scale. However, the coefficients used to compute turbulence from acceleration appear inadequate. The Poisson statistical law is confirmed as suitable to describe turbulence distribution. Author (ESA)

N86-17341# Bundesanstalt fuer Flugsicherung, Frankfurt am Main (West Germany). Buero der Nachrichten fuer Luftfahrer.
ENVIRONMENT-FRIENDLY PROPELLER AIRCRAFT WITH A MAXIMUM WEIGHT OF 5700 KG, AND MOTOR GLIDERS: PUBLICATION OF THE NOISE VALUES [UMWELTFREUNDLICHE PROPELLERFLUGZEUGE BIS 5700 KG HOECHSTMASSE UND MOTORSEGLER: VEROEFFENTLICHUNG DER LAERMWERTE]
31 Oct. 1983 25 p In GERMAN
Avail: NTIS HC A02/MF A01

The noise values (status October 31, 1983) of all prototypes and series of propeller aircrafts and motor gliders fulfilling the standard MfLII-47/75 or the noise protection requirements for aircraft LSL (April 23, 1981) are listed. Equipment, maximum permissible cruising power, maximum permissible number of revolutions, initial mass, temperature corrected noise level, power correction value, certified noise level, and noise threshold are given. Author (ESA)

N86-17342# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
DAMAGE-TOLERANT AIRCRAFT DESIGN
H. P. VANLEEUWEN 23 Jan. 1984 30 p refs Presented at 5th European Conference on Fracture, Lisbon, Portugal, 17-21 Sep. 1984
(NLR-MP-84005-U; B8568522) Avail: NTIS HC A03/MF A01

Actions to be taken to realize a damage-tolerant aircraft structure and to have it certified are listed. Studies to define aircraft usage, missions; develop load spectra, sequences; select critical locations for an evaluation; develop stress spectra for those locations; determine environmental conditions for those locations; compile crack growth data for each material and environment; compile fracture toughness data; produce crack growth curves; determine residual strength; decide on inspection techniques; determine detectable crack length; and decide on inspection intervals are summarized. Full scale tests on an F-28 aircraft wing are described. Author (ESA)

N86-17343# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
HELICOPTER-SHIP QUALIFICATION TESTING
R. FANG, T. J. HOEKSTRA, and C. F. G. M. HOFMAN 18 Jun. 1984 19 p Submitted for publication
(NLR-MP-84062-U; B8568102) Avail: NTIS HC A02/MF A01

Helicopter-ship qualification tests are reviewed. The total program comprises wind-tunnel tests on a scale model of the ship, full scale wind climate tests on board the ship, shore-based helicopter flight tests in the low speed region, and helicopter flight tests on board the ship. The program leads to a safe and optimum operational availability of the helicopter on board the ship in terms of take-off, landing and deck handling capabilities as a function of relative wind and sea-state. Author (ESA)

N86-17344# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
DESIGN AND FABRICATION OF AN ADVANCED COMPOSITE CELLULAR WING BOX
G. ROMEO (Polytecnico di Torino, Italy) and W. H. M. VANDREUMEL 1984 23 p refs
(VTH-LR-315) Avail: NTIS HC A02/MF A01

A cellular integral structure was designed for the upper and lower panels of a wing box in order to realize a ribless structure. A small panel was manufactured and tested under uniaxial compression. A wing box (length 1300mm) was manufactured.
Author (ESA)

N86-17345# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
LECTURE NOTES ON FATIGUE, STATIC TENSILE STRENGTH AND STRESS CORROSION OF AIRCRAFT MATERIALS AND STRUCTURES. PART 2: FIGURES
J. SCHIJVE Aug. 1983 121 p refs
(VTH-LR-360-PT-2; B8563474) Avail: NTIS HC A06/MF A01

Graphs, photographs, and figures from a report on aircraft materials and structures tests are presented. Author (ESA)

N86-17346# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
OPERATIONAL APPLICATION OF THE STALINS METHOD FOR MEASURING TAKE-OFF AND LANDING TRAJECTORIES
C. G. KRANENBURG, A. POOL, and A. J. L. WILLEKENS 15 Apr. 1983 55 p refs Revised
(Contract NIVR-1899)
(NLR-TR-83010-U; B8569023) Avail: NTIS HC A04/MF A01

The STALINS method to calculate the trajectories from the outputs of an inertial sensing system is described and compared with results obtained from onboard cameras and a radio altimeter from 200 takeoff and landing flight tests. The comparison shows that the STALINS method is at least as accurate as the other methods and meets its design goals. Author (ESA)

N86-17347# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
THREE-DIMENSIONAL FLIGHT-PATH RECONSTRUCTION BY MEANS OF SPLINE APPROXIMATION
M. R. BEST 30 Jul. 1985 67 p refs
(Contract NIVR-1816)
(NLR-TR-83091-U; B8568391) Avail: NTIS HC A04/MF A01

A method to reconstruct the flight path of a symmetric flight, by representing this path by a set of splines, was applied to a three-dimensional flight over a rotating Earth. Results are comparable in accuracy and computing time to the Kalman (square root information) smoother, but reduction in computing time seems feasible. Author (ESA)

N86-17348# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
ESTIMATION OF LOAD EXCEEDANCES OF AN AIRCRAFT UNDER CARRIAGE WITH NONLINEAR PROPERTIES EXCITED BY RANDOM RUNWAY UNEVENNESS
R. NOBACK 20 Mar. 1984 94 p refs
(Contract NIVR-1947)
(NLR-TR-84030-U; B8568529) Avail: NTIS HC A05/MF A01

Methods to describe a landing gear with nonlinear properties excited by random runway unevenness during taxiing were investigated. Calculations were compared to measured results from an analog computer simulation. The mean behavior, standard deviations, and power spectra can be described with a classic type of equivalent gain. Load exceedance curves can be approximated fairly well with conditional equivalent gains that depend on the output load level. Author (ESA)

N86-17349# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
OPTIMIZATION IN DESIGN PROCESSES: AN INFORMATICS POINT OF VIEW
R. F. VANDENDAM, J. W. BOERSTOEL, and H. A. M. DANIELS 3 Aug. 1984 33 p refs Presented at International Conference on Inverse Design Concepts in Engineering Science (ICIDES), Austin, Tex., Oct. 1984 Submitted for publication
(NLR-MP-84074-U; B8569324) Avail: NTIS HC A03/MF A01

Optimization system development and the potential of mathematical optimization techniques in aeronautical engineering are discussed. The main requirements to be met by a general-purpose optimization system are given. Implementation is described, and examples of applications are presented.
Author (ESA)

N86-17350# Societe Nationale Industrielle Aerospatiale, Marignane (France). Helicopter Div.
STRATEGIES FOR DYNAMIC MODELING OF A HELICOPTER STRUCTURE
S. DURAND and V. YANA 1985 12 p refs Presented at 11th European Rotorcraft Forum, London, England, 10-13 Sep. 1985
(SNIAS-852-210-101) Avail: NTIS HC A02/MF A01

Helicopter dynamic modeling problems are studied using three principles: divide difficulties, correlate with test and simplify reality. The analytical procedures that were used include the finite element method, modal analysis, harmonic analysis and transient analysis. The method is applied to the tail section of the Ecureil helicopter. Good correlation between natural frequency modes as measured and calculated is obtained over nine vibrating modes. The forced response calculations allowed to find a solution to a problem of unbalance excitation caused by the tail rotor. Author (ESA)

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A86-19571
LASER SYSTEMS FOR USE WITH AIRBORNE PLATFORMS
J. JEPSKY (Associated Controls and Communications, Inc., Salem, MA) IN: The National Symposium and Workshop on Optical Platforms, Huntsville, AL, June 12-14, 1984, Proceedings . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 435-442.

The use of pulsed gallium arsenide and yttrium-aluminum-garnet laser systems for profiling, altimetry, photogrammetric control, collision avoidance, and shipboard landing systems is examined. Laser transmitters operate at pulse rates up to 4 KHz, at peak power outputs up to 100 watts, and a 10-50 nanosecond pulse width. The techniques utilized by the rangefinders for the measurement circuitry are discussed. In order to evaluate the accuracy of the range measurements the signal-to-noise ratio is calculated. Operation of the laser system for profiling, with a control console and a single board computer is analyzed. Examples of profiles obtained using the laser system are presented. The SKEET Delivery System and the SKEET Delivery Vehicle Assembly are described. I.F.

A86-19576
AIRBORNE RECONNAISSANCE VIII; PROCEEDINGS OF THE MEETING, SAN DIEGO, CA, AUGUST 21, 22, 1984
P. HENKEL, ED. (General Dynamics Corp., Fort Worth, TX) and F. R. LAGESSE, ED. (McDonnell Aircraft Co., St. Louis, MO) Meeting sponsored by SPIE - The International Society for Optical Engineering. Bellingham, WA, SPIE - The International Society for Optical Engineering (SPIE Proceedings. Volume 496), 1984, 186 p. For individual items see A86-19577 to A86-19602.
(SPIE-496)

Various papers on sensors and ancillary equipment, technological advances, development and testing, and intelligence extraction and exploitation in airborne reconnaissance are presented. The topics discussed include: the CA-810 modern trilens camera, PC-183B standoff imaging system, ruggedized MMW radiometer sensor for surveillance applications, application of biocular viewers to airborne reconnaissance, KA-102 film/EO standoff system, KS-146A camera development and flight test results, electrooptical imaging for film cameras, and new generation advanced IR linescan sensor system. Also addressed are: evolution of real time airborne reconnaissance, computer-controlled operation of reconnaissance cameras, miniature focus sensor, microprocessor-controller autofocus system, camera flight tests and image evaluation, LM-230A cost-effective test system, information management for tactical reconnaissance, performance modeling of infrared linescanners and FLIRs, USAF tactical reconnaissance - Grenada, sensor control and film annotation for long-range standoff reconnaissance, laser beam recording on film, meteorological effects on image quality, and optimization of photographic information transfer by CRT. C.D.

A86-19577
THE CA-810 - A MODERN TRI-LENS CAMERA
G. LEWIS (Recon/Optical, Inc., Barrington, IL) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 6-12.

Advances in electronic technology have allowed the camera designer more latitude in choosing how each camera function is to be performed. This paper describes the CA-810 camera design, showing how modern technology allows the configuration of a camera to meet both high airborne performance and reliability. The CA-810 camera uses three 80-mm, f/2.0 lenses and two prisms to provide over 140 deg across the line of flight by 47 deg

in the line of flight coverage. It is similar in general arrangement to the KA-63 camera produced in 1963. The CA-810 camera is capable of operation at cycle rates up to 12.6 frames/s. Results of tests on the CA-810 camera are vgiven, demonstrating the effectiveness of the use of modern technology in the design of a new low altitude, high cycle rate camera. Author

A86-19578
PC-183B STANDOFF IMAGING SYSTEM
H. J. FREDRICKSON (Itek Corp., Optical Systems Div., Lexington, MA) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 13-18.

Itek has recently completed a program to supply long range oblique photography (LOROP) cameras for a nose installation in an F-104 aircraft. The camera, designated PC-183B, is a derivative of a configuration presented at the June 1980 SPIE show. The PC-183B camera features reflective optics, internal two-axis stabilization, and a unique air capstan. Author

A86-19580
APPLICATION OF BIOCULAR VIEWERS TO AIRBORNE RECONNAISSANCE
H. G. ELDERING (Baird Corp., Government Systems Div., Bedford, MA) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 27-30.

Biocular viewers permit magnification of small areas without optical distortion and produce an image that can be viewed with both eyes. Current applications range from biocular viewing of driftsights, image intensifiers, or FLIR displays while in a moving vehicle, to quick scanning of reconnaissance imagery in ground based photointerpreter facilities. Other potential applications include allowing the use of space-saving devices available only in small formats, such as liquid crystal video displays. Advantages include absence of facial contact, no diopter adjustment necessary, operator may wear glasses incorporating astigmatic corrections, and wide angle viewing (45-deg field of view) to allow correct perspective presentation. The lack of distortion reduces eye fatigue and reduces the likelihood of nausea while viewing in an unstable environment. Distortion inherent in certain image intensifier tubes can be partially corrected with a biocular viewer. Author

A86-19581
KA-102 FILM/EO STANDOFF SYSTEM
R. T. TURPIN (Itek Corp., Optical Systems Div., Lexington, MA) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 31-41.

An assessment is made of the design features and performance capabilities of the KA-102 airborne reconnaissance camera, which possesses a film-or-electrooptic (EO) selection feature and is coupled to a real time data link. The EO focal plane is a continuous line array of 10,240 CCD elements operating in the 'pushbroom' mode. EO imagery can be transmitted up to 500 nm at 75 Mbit/sec. At the ground station, the imagery is calibrated and displayed in real time on three CRTs; image enhancement and magnification for detailed study may be undertaken, as well. O.C.

A86-19583
KS-146A CAMERA DEVELOPMENT AND FLIGHT TEST RESULTS
T. AUGUSTYN (Recon/Optical, Inc., Barrington, IL) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 50-55.

In 1979, there began the development of the KS-146 A 1676-mm focal length, f/5.6 frame camera system designed exclusively for long range oblique photographic missions. The goal was to produce a stabilized system tailored for use with relatively slow, but high-definition films such as EK 3412 and 3414, while also providing growth potential to an electro-optical (E-O) real-time sensor. A detailed design description of the system was presented in 1981. Since then, six systems have been fabricated, evaluated and flight tested over a wide range of airborne conditions. All systems are now operational and the results obtained have confirmed that all objectives have been achieved. Airborne resolution of 8.5 microrad has consistently been demonstrated at slant ranges exceeding 30 n mi. Modular construction, and the flexibility inherent in the KS-146A design, makes the conversion to an E-O sensor straightforward, and the effort to expand the capabilities of the system have begun. Details of the camera development and a review of flight test results are presented. The modification to convert the system to near real time are also discussed. Author

A86-19585
A NEW GENERATION ADVANCED I.R. LINESCAN SENSOR SYSTEM
D. B. DUKE, G. B. MCQUEEN, and P. V. ADAMS (British Aerospace, PLC, Dynamics Group, Hatfield, England) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 61-70.

One of an advanced generation of infrared Linescan Sensors with superior performance, small size, and low weight is described. These systems provide horizon to horizon across-track coverage which, coupled with electronic roll stabilization, provides a far greater probability of target detection than earlier systems. The optics, detector, cooling system, and electronics of the sensor are described, as are the three Line Replaceable Units in the system. C.D.

A86-19586
EVOLUTION OF REAL TIME AIRBORNE RECONNAISSANCE
W. J. UTTLEY-MOORE, R. CAREW-JONES, T. MORGAN, P. J. WILLIAMS, and R. C. RANKIN (Computing Devices Co., St. Leonards-on-Sea, England) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 71-78.

An outline of the requirements for a modern reconnaissance system as fitted to a tactical strike aircraft is presented. Film based reconnaissance systtems, as used in many existing installations, are discussed with emphasis on their failure to meet many of the requirements. Systems providing aircrew with immediate access to sensor data are discussed. Particular emphasis is given to the Panavia Tornado RMS 3000 system utilizing video tape and cockpit imagery. A basic ground station whihc could be used with the RMS 3000 system is discussed, stressing the wide range of facilities provided. The paper concludes with some future possibilities for this type of system. Author

A86-19587
COMPUTER CONTROLLED OPERATION OF RECONNAISSANCE CAMERAS
R. LYON, A. BIENER, and F. PALAZZO (Fairchild Weston Systems, Inc., Syosset, NY) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 79-81.

Reconnaissance cameras are now controlled by real-time computer/microprocessor systems. The processor may control the camera stabilization and scanning, autofocus, exposure control and data annotation functions. Operator interface may be minimal with a simple control panel or quite extensive with sophisticated display/keypad subsystems. Target selection may be controlled by an operator or the camera may be automatically driven by the processor system using a predetermined mission profile updated by aircraft flight data. Author

A86-19588
AUTOMATIC EXPOSURE CONTROL EMPLOYING SCENE STATISTICS IN RECONNAISSANCE CAMERAS
R. LYON (Fairchild Weston Systems, Inc., Syosset, NY) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 82-84.

A method is described for modifying the exposure value in aerial reconnaissance using an automatic process which discriminates against nonrelevant information. A microprocessor is used to determine the best exposure value based on scene statistics. Brightness data are obtained from a 'look-ahead' CCD sensor, and scene statistics are computed and processed using an exposure control algorithm. The use of the hardware employed in this method is described. C.D.

A86-19591
CAMERA FLIGHT TESTS AND IMAGE EVALUATION
U. J. V. RINGH (Forsvaret Materielverk, Linkoping, Sweden) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 94-100. refs

This paper describes camera flight tests and image evaluation for conventional cameras as they are carried out by the Swedish Defense Material Administration (FMV). The image evaluation method used is resolving power by use of three bar target. A special square target (4 x 4 m) is also used to measure contrast ratio on the film with a microdensitometer. Results of contrast measurements are given from tests carried out in good weather conditions with a horizontal visibility of more than 30 km. The measured contrast ratios and theoretical predicted values have been compared. The model used for this prediction of atmospheric contrast reduction is compiled from known literature. The comparison shows that the model used for the prediction was usable. Author

A86-19597
SENSOR CONTROL AND FILM ANNOTATION FOR LONG RANGE, STANDOFF RECONNAISSANCE
T. G. SCHMIDT, O. L. PETERS, and L. H. POST (McDonnell Douglas Electronics Co., St. Charles, MO) IN: Airborne reconnaissance VIII; Proceedings of the Meeting, San Diego, CA, August 21, 22, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 134-141.

This paper describes a Reconnaissance Data Annotation System that incorporates off-the-shelf technology and system designs providing a high degree of adaptability and interoperability to satisfy future reconnaissance data requirements. The history of data annotation for reconnaissance is reviewed in order to provide the base from which future developments can be assessed and technical risks minimized. The system described will accommodate new developments in recording heat assemblies and the incorporation of advanced cameras of both the film and electro-optical type. Use of microprocessor control and digital bus interface form the central design philosophy. For long range, high altitude, standoff missions, the Data Annotation System computes the projected latitude and longitude of central target position from aircraft position and attitude. This complements the use of longer ranges and high altitudes for reconnaissance missions. Author

A86-19617
AIR TARGETING OF THE THIRD KIND - AIRBORNE VEHICLES
J. F. GILMORE (Georgia Institute of Technology, Atlanta) IN: Applications of digital image processing VII; Proceedings of the Meeting, San Diego, CA, August 21-24, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 330-340. refs

The majority of research in the area of image analysis over the last several years has centered on ground-based object and region analysis. Recent events have stirred an interest in the detection and classification of aircraft in flight. This paper surveys the six algorithms which have been successful applied to the problem of aircraft classification. Each algorithm is analyzed in terms of relative strengths and weaknesses. Summary results of the filter operators, aircraft types, evaluation imagery, problems addressed, and algorithm assumptions are presented for each approach considered. Author

A86-19620
TOWARDS ROBUST IMAGE MATCHING ALGORITHMS
T. J. PARSONS (British Aerospace, PLC, Dynamics Group, Hatfield, England) IN: Applications of digital image processing VII: Proceedings of the Melting, San Diego, CA, August 21-24, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 436-444. refs

An effort to develop a robust image matching system suitable for use in an automatic image matching navigation system with a thermal IR sensor is reported. First, the requirements for an image matching algorithm are formulated, and the image data-base used in the study is described. An overview is then presented of a suggested image processing based navigation system, with attention given to preprocessing, processing, feature extraction, and to the Scene Matching by Area Correlation system. It is shown that the best edge maps for a wide variety of images are obtained by looking for edge crossing in a D.O.G. (Difference of Gaussian) convolved image significantly above the noise level. Finally, the use of techniques based on relational graphs in developing a robust image matching algorithm and the concept of the Problem Based Language Extension are briefly reviewed. V.L.

A86-19636*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DESCRIPTION OF AND RESULTS FROM CAMERA SYSTEMS FOR RECORDING DAYTIME LIGHTNING STRIKES TO AN AIRPLANE IN FLIGHT
P. W. BROWN (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 14 p.
(AIAA PAPER 84-0020)

Photographic still and movie and video camera systems have been developed to reveal more about the characteristics of daytime lightning strikes to airplanes in flight. Equipment selection and design is particularly important with regard to time of event occurrence, time correlation between cameras, rapidity of actuation, ease of photogrammetric analysis, and selection of fields of view. The most recent such camera systems flown in an NASA F-106B research airplane are described and design considerations are discussed. Daytime depictions of lightning strikes are presented as illustrative of some of these considerations. Author

A86-19764*# Systems Control Technology, Inc., Palo Alto, Calif.
DEVELOPMENT OF A KNOWLEDGE ACQUISITION TOOL FOR AN EXPERT SYSTEM FLIGHT STATUS MONITOR
J. D. DISBROW (Systems Control Technology, Inc., Palo Alto, CA), E. L. DUKE, and V. A. REGENIE (NASA, Flight Research Center, Edwards, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. refs
(AIAA PAPER 86-0240)

Two of the main issues in artificial intelligence today are knowledge acquisition and knowledge representation. The Dryden Flight Research Facility of NASA's Ames Research Center is presently involved in the design and implementation of an expert system flight status monitor that will provide expertise and knowledge to aid the flight systems engineer in monitoring today's advanced high-performance aircraft. The flight status monitor can be divided into two sections: the expert system itself and the knowledge acquisition tool. This paper discusses the knowledge acquisition tool, the means it uses to extract knowledge from the domain expert, and how that knowledge is represented for computer use. An actual aircraft system has been codified by this tool with great success. Future real-time use of the expert system has been facilitated by using the knowledge acquisition tool to

easily generate a logically consistent and complete knowledge base. Author

A86-20505
A HIGH BANDWIDTH SIGNAL DISTRIBUTION SYSTEM FOR AIRCRAFT STORES MANAGEMENT SYSTEMS (SMS)
F. LUPINETTI, F. INGELS (Mississippi State University, MS), and R. DUNN (USAF, Eglin AFB, FL) IN: SOUTHEASTCON '84; Proceedings of the Conference, Louisville, KY, April 8-11, 1984 . New York, Institute of Electrical and Electronics Engineers, 1984, p. 164-168.
(Contract F08635-82-K-0375)

A model is presented of an FDM (frequency division multiplexing) system for high bandwidth video information transfer for military aircraft according to the MIL-STD 1760 requirements. The choice for an active bus system is briefly justified and numerical results obtained with a simulation computer program are used to illustrate the performance of the model. D.H.

A86-21163#
DEVELOPMENT OF AN AIRBORNE CCD SCANNER FOR LAND AND SEA APPLICATIONS
N. J. J. BUNNIK, H. POUWELS, L. AARTMAN, P. BINNENKADE (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands), C. SMORENBURG (Centrale Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek, Technisch Physische Dienst TNO, Delft, Netherlands) et al. IN: International Symposium on Remote Sensing of Environment, 18th, Paris, France, October 1-5, 1984, Proceedings. Volume 2 . Ann Arbor, MI, Environmental Research Institute of Michigan, 1985, p. 713-721.

An airborne multispectral scanner based on the use of CCD detector arrays has been developed. The device is known as CAESAR (CCD Airborne Experimental Scanner for Applications in Remote sensing). The CAESAR project has mainly the objective to increase Dutch experience with respect to the application of CCD detectors for earth observation, giving particular attention to the exploration of the technical problem areas associated with the use of CCD detectors. A second objective is related to the stimulation of application-oriented research in the use of multispectral data for land and sea observation by means of a versatile system specified by existing user requirements. After the development and test phase, the project will be continued with an application-oriented evaluation phase to be executed in 1985. The present article provides a description of the user specifications, the design of the sensor system, and the onboard data handling system. Attention is given to the first results of flight tests conducted in July 1984. G.R.

A86-21234#
UNITED STATES COAST GUARD ACQUISITION OF REMOTE SENSING CAPABILITY FOR OCEAN SURVEILLANCE
J. R. WHITE (USCG, Washington, DC) IN: International Symposium on Remote Sensing of Environment, 18th, Paris, France, October 1-5, 1984, Proceedings. Volume 3 . Ann Arbor, MI, Environmental Research Institute of Michigan, 1985, p. 1605-1615.

An account is given of the U.S. Coast Guard development of an airborne, real-time, all-weather, day/night remote sensing system that will detect oil slicks at sea and identify violating vessels. The system has been designated 'Aireye' and will be installed on six of the 41 new Falcon 20 G jet aircraft (military designation HU-25A) which the Coast Guard has recently purchased as its medium range surveillance aircraft. The sensor system will include a side-looking airborne radar, three channel IR/UV line scanner, aerial reconnaissance camera, airborne data annotation system, and a control-display-record console. An active gated television camera will be used to identify vessels at night. D.H.

A86-22386
ANALYSIS OF THE F/A-18 HORNET FLIGHT CONTROL COMPUTER FIELD MEAN TIME BETWEEN FAILURE
P. GRIFFIN (General Electric Co., Aerospace Control Systems Dept., Binghamton, NY) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 108-114.

The F/A-18 FCSE (Flight Control System Electronics) is a four channel (quad redundant) digital fly-by-wire system contained in nine Weapon Replaceable Assemblies (WRA's). The system is built by an American aerospace company. The present paper is concerned with the Flight Control Computer (FCC) which is the heart of the quad configuration for the FCSE. Each computer contains dual channels. Included in the conducted analysis are 131 relevant failures for a total of 62,769 aircraft operating hours, or 125,538 FCC operating hours. The field experienced MTBF (Mean Time Between Failure) of 958 is compared against the predicted MTBF of 851. Attention is given to problems arising in connection with reliability predictions, reliability planning and management philosophy, part type failure distribution, reliability prediction based on updated integrated circuit junction temperatures, and the IC environmental duty cycle. G.R.

N86-16212*# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
FINDS: A FAULT INFERRING NONLINEAR DETECTION SYSTEM PROGRAMMERS MANUAL, VERSION 3.0
R. E. LANCRAFT Dec. 1985 174 p refs
(Contract NAS1-16579)
(NASA-CR-177986; NAS 1.26:177986; REPT-6012) Avail: NTIS HC A08/MF A01 CSCL 01D

Detailed software documentation of the digital computer program FINDS (Fault Inferring Nonlinear Detection System) Version 3.0 is provided. FINDS is a highly modular and extensible computer program designed to monitor and detect sensor failures, while at the same time providing reliable state estimates. In this version of the program the FINDS methodology is used to detect, isolate, and compensate for failures in simulated avionics sensors used by the Advanced Transport Operating Systems (ATOPS) Transport System Research Vehicle (TSRV) in a Microwave Landing System (MLS) environment. It is intended that this report serve as a programmers guide to aid in the maintenance, modification, and revision of the FINDS software. Author

N86-16214# Army Test and Evaluation Command, Aberdeen Proving Ground, Md.
STRESS LEVEL TESTING OF ELECTRONICS, AVIONICS COMMUNICATIONS AND C3I EQUIPMENTS Final Report
30 Aug. 1985 28 p
(AD-A159395; TOP-6-1-002) Avail: NTIS HC A03/MF A01 CSCL 17B

This Test Operations Procedure (TOP) describes test methods and techniques for measuring and evaluating the technical performance of a System Under Test (SUT) when the SUT is operated to and beyond specifications in order to determine its response to high levels of stimuli. The extremely short period allowed for the writing of this TOP along with the great diversity of potential systems to be tested has precluded the writing of a document which conclusively covers the topic of stress level testing. This document should be considered as a TOP which outlines the basic requirements and the basic test methodology for conducting stress level testing. This TOP includes only the electronics aspect of stress level testing. It does not consider the classical environmental and mechanical stress testing of materials; these types of stress testing are covered in MIL-STD-810D.
GRA

N86-16215# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
DESIGN AND EVALUATION OF AN INSTRUMENTATION SYSTEM FOR MEASUREMENTS IN NONSTEADY SYMMETRICAL FLIGHT CONDITIONS WITH THE HAWKER HUNTER MK 7
K. VANWOERKOM 1984 83 p refs
(VTH-LR-308) Avail: NTIS HC A05/MF A01

A flight test instrumentation system with a sample of rate 400 measurements/sec, and 0.02% overall accuracy is described. The system was used to perform nonsteady symmetric flight tests with a Hawker Hunter aircraft. The design and evaluation of transducers, signal conditioning, and the data collection system are outlined. The program demonstrates the technique of measuring performance characteristics as well as stability and control characteristics simultaneously in dynamic flight conditions.
Author (ESA)

N86-17351*# Illinois Univ., Urbana-Champaign. Computer Systems Group.
ERROR PROPAGATION IN A DIGITAL AVIONIC PROCESSOR: A SIMULATION-BASED STUDY
D. LOMELINO and R. K. IYER 1986 39 p refs
(Contract NAG1-613)
(NASA-CR-176501; NAS 1.26:176501) Avail: NTIS HC A03/MF A01 CSCL 01D

An experimental analysis to study error propagation from the gate to the chip level is described. The target system is the CPU in the Bendix BDX-930, an avionic miniprocessor. Error activity data for the study was collected via a gate-level simulation. A family of distributions to characterize the error propagation, both within the chip and at the pins, was then generated. Based on these distributions, measures of error propagation and severity were defined. The analysis quantifies the dependency of the measured error propagation on the location of the fault and the type of instruction/microinstruction executed. Author

N86-17352# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
THE APPLICATION OF SENSORS IN LIGHT TESTS
S. S. VANLEEUWEN 16 May 1984 12 p refs Presented at 2nd S and A Symposium, Enschede, Netherlands, 1-2 Nov. 1984
(NLR-MP-84056-U; B8568098) Avail: NTIS HC A02/MF A01

Evaluation of transducers used in flight test data collection systems is described. Needs for flight test transducers are discussed. Static laboratory tests, duration tests, environmental tests, and tests in laboratory aircraft are outlined. Pressure, temperature, position, acceleration, vibration, and sound transducers, and gyros are covered. Author (ESA)

N86-17353# Kollsman System-Technik G.m.b.H., Munich (West Germany).
DEVELOPMENT OF A PIEZOELECTRIC QUARTZ PRESSURE SENSOR FOR AVIONICS WITH EXCELLENT LONG TERM STABILITY (WITH FINAL DEMONSTRATION OF THE RESULTS ON A PROTOTYPE) Final Report, Nov. 1984
M. R. RISCH Bonn, West Germany Bundesministerium fuer Forschung und Technologie Aug. 1985 72 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie, Bonn, West Germany
(BMFT-FB-W-85-010; ISSN-0170-1339) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 15

An accurate, stable pressure sensor was developed for avionics using quartz as a pressure-sensitive element, a copper-beryllium beam balance for pressure transfer, calculators for digitization, and two identical high frequency piezoelectric surface wave resonators for improved accuracy. Sensor pressure and temperature dependence were tested. Pressure sensitivity changes with temperature, at 0.05% per C. As errors are 0.1% for hysteresis, repeatibility, temperature hysteresis, and long term drift, the pressure sensor can be mass produced. Nonlinearity and temperature dependence are 1% but can be compensated with a microprocessor. Author (ESA)

N86-17354# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
RELIABILITY ASPECTS OF SOFTWARE FOR DIGITAL AVIONICS
G. J. DEKKER 1985 95 p refs Revised
(Contract RB-RLB-1982-1-3.3)
(NLR-TR-82126-U; B8568394) Avail: NTIS HC A05/MF A01

Methods to develop reliable software based avionics systems, especially for safety critical functions, are reviewed. The differences between analog and digital systems, and the policy of the FAA to certify software based systems are presented. Methods to minimize the number of errors during software development, methods to remove as many errors as possible via testing, and methods to minimize the effect of remaining errors during operational flights are outlined. A safety analysis regarding common-mode failures is given. Reliability related techniques used by avionics manufacturers are discussed. Author (ESA)

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A86-19677*# Purdue Univ., West Lafayette, Ind.
AN EXPERIMENTAL INVESTIGATION OF PROPELLER WAKES USING A LASER DOPPLER VELOCIMETER
R. M. SUNDAR (Embry-Riddle Aeronautical University, Prescott, AZ) and J. P. SULLIVAN (Purdue University, West Lafayette, IN) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 7 p.
(Contract NSG-3135)
(AIAA PAPER 86-0080)

The results of experimental investigations on three single rotation propellers are summarized in this paper. Force measurements showed a definite improvement in efficiency at low advance ratios and in static operation due to use of proplets. Extensive velocity measurements were made using a LDV system. The large amounts of data gathered are presented to reveal clearly the tip vortex streaming back from the propeller. The velocities were also processed using momentum theorem to obtain the thrust and power radial distributions as well as the integrated thrust and power coefficients. The thrust coefficient compared well with force measurements and theoretical prediction from vortex lattice and Goldstein analysis. However, the power coefficient calculated from the momentum analysis was consistently lower than the theoretical or measured values. The measured velocities were also used to compute the vorticity and the trajectory of the tip vortex in the wake behind the propeller. Author

A86-19678*# Flow Research, Inc., Kent, Wash.
PROPELLER DESIGN BY OPTIMIZATION
M. H. RIZK and W.-H. JOU (Flow Industries, Inc., Kent, WA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. refs
(Contract NAS3-24533)
(AIAA PAPER 86-0081)

The feasibility of designing propellers by an optimization procedure is investigated. A scheme, which solves the full potential flow equation about a propeller by line relaxation, is modified so that the iterative solutions of the flow equation and the design parameters are updated simultaneously. Some technical problems in using optimization for designing propellers with maximum efficiency are identified. Approaches for overcoming these problems are presented. Author

A86-19853#
SMALL SCALE WIND TUNNEL TESTING OF MODEL PROPELLERS
R. M. BASS (Dowty Rotol, Ltd., Gloucester, England) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. refs
(AIAA PAPER 86-0392)

The difficulty and cost of measuring the performance of full scale propellers can be avoided by the use of models operating at correct Mach numbers. Inevitably the Reynolds numbers are low and it is a matter of great difficulty to scale model behavior to full size. In order to obtain a better understanding of scale effects a series of experiments has been conducted in a variable density tunnel in which the separate effects of Reynolds number and Mach number were studied and conclusions drawn as to the limit of validity of model tests. In addition to the obvious effects of Reynolds and Mach number, other effects present are being investigated. To explore the pressure distribution over the blades, a rig has been constructed in which blade surface pressure on a rotating model can be measured. The rig is described and the salient features of data reduction discussed. Some results indicating the potential of the rig are presented. Author

A86-19888#
INFRARED EMISSION FROM JET ENGINE EXHAUST PLUMES
H. F. NELSON (Missouri-Rolla, University, Rolla) and E. O. TUCKER AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. Research supported by McDonnell Douglas Astronautics Co. refs
(AIAA PAPER 86-0465)

B2O3 particle IR scattering and emission property data concerning scattering cross sections, albedo, and scattering phase functions, which were generated on the basis of radiative reflection and transmission data from the literature, are subjected to a Kramers-Kronig analysis in order to convert radiative data into index-of-refraction values. Scattering parameters required by the Standardized IR Radiation Model (SIRRM) code are obtained from the refractive index values using Mie scattering analysis for 2-25 micron wavelength radiation. SIRRM is used to calculate the broadside IR radiation emitted from isothermal and homogeneous models of turbojet and ramjet exhaust plumes, and it is found that radiant emission increases with increasing particle size and particle mass loading. O.C.

A86-19895*# Stanford Univ., Calif.
ANALYSIS OF INTERACTING DUAL LIFTING EJECTOR SYSTEMS
T. S. LUND, D. A. TAVELLA, and L. ROBERTS (Stanford University, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(Contract NCC2-150)
(AIAA PAPER 86-0478)

An analytical treatment is presented for a flowfield generated by a pair of interacting, two-dimensional parallel jets, representative of the two exhaust streams issuing from the thrust augmentor nozzles of dual lifting jet VTOL aircraft propulsion systems. Predictions of the analysis for the ratio of primary to secondary velocity are in close agreement with experimentally observed values, if the spreading rate parameter is allowed to assume a value greater than that which applies to a free jet. Theoretical results are combined with existing experimental data for unventilated jets, in order to arrive at an estimate of the thrust augmentation produced by a jet pair with an arbitrary degree of ventilation. O.C.

A86-19965#
AN ANALYTICAL INVESTIGATION OF THE EFFECTS OF SWIRLER DESIGN ON THE PERFORMANCE OF ANNULAR PROPULSIVE NOZZLES
J. D. HOFFMAN, H. D. THOMPSON, and D. L. MARCUM (Purdue University, West Lafayette, IN) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. USAF-sponsored research. refs
(AIAA PAPER 86-0587)

An analytical performance prediction methodology for annular propulsive nozzles with swirl introduced in the combustor upstream of the nozzle is presented. The methodology is applied to investigate the effects of swirler design on the performance of annular propulsive nozzles. Four types of swirlers were investigated: free vortex, constant angle, forced vortex, and Rankine vortex swirlers. Discharge coefficients, specific impulses, and wall pressure distributions are presented. These numerical studies show that the discharge coefficient, the thrust, and the vacuum specific impulse decrease as the amount of swirl increases, but that the decrease in specific impulse is modest. The effect of swirl on the discharge coefficient, for all four swirler designs, correlates well with the mass-averaged swirl introduced into the flowfield by the swirler. However, the decrease in vacuum specific impulse is a function of the swirler design. The forced vortex swirler has the least decrease in specific impulse with increasing swirl while the free vortex swirler has the greatest decrease. This methodology will enable nozzle designers to account for the effects of swirl in nozzle design. Author

A86-20233*# Massachusetts Inst. of Tech., Cambridge.
LINEAR-QUADRATIC GAUSSIAN WITH LOOP-TRANSFER RECOVERY METHODOLOGY FOR THE F-100 ENGINE
M. ATHANS, P. KAPASOURIS, E. KAPPOS, and H. A. SPANG, III (MIT, Cambridge, MA) (Guidance and Control Conference, Seattle, WA, August 20-22, 1984, Technical Papers, p. 434-444) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Jan.-Feb. 1986, p. 45-52. Research supported by General Electric Corp. Previously cited in issue 21, p. 2997, Accession no. A84-43450. refs
(Contract NAG2-297; NGL-22-009-124)

A86-20369*# Texas A&M Univ., College Station.
A NUMERICAL METHOD FOR THE DESIGN AND ANALYSIS OF COUNTER-ROTATING PROPELLERS
S. C. PLAYLE, K. D. KORKAN, and E. VON LAVANTE (Texas A & M University, College Station) Journal of Propulsion and Power (ISSN 0748-4658), vol. 2, Jan.-Feb. 1986, p. 57-63. refs
(Contract NAG3-354)
(AIAA PAPER 84-1205)

A numerical method has been developed using the techniques of Lock and Theodorsen as described by Davidson to design and analyze counter-rotating propellers. The design method develops the optimum propeller geometry by calculating the planform and twist distribution for each propeller disk through the use of specific inputs of engine shaft horsepower, diameter, and disk spacing. The analysis method calculates the performance of a given counter-rotating propeller system at any flight condition. Using the NACA four-digit airfoil family, the performance of a counter-rotating propeller design for a given flight condition was investigated in the design and analysis mode. Author

A86-20371
VARIABLE CYCLIC TURBOSHAFT TECHNOLOGY FOR ROTORCRAFT OF THE '90S
C. ROGO and E. H. BENSTEIN (Teledyne CAE, Toledo, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 2, Jan.-Feb. 1986, p. 73-80. Army-sponsored research. Previously cited in issue 18, p. 2622, Accession no. A85-39695. refs

A86-20448#
DISPERSION PROCESS OF JET ENGINE EXHAUST PLUME. II - BUOYANT JET
A. NISHI (Miyazaki University, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 28, Oct. 1985, p. 2360-2364.

In the previous paper the initial dispersion process of jet engine exhaust plume was discussed with the data of jet engine field test as well as those of the model test. The momentum dominant region in the jet was treated mainly, and the model test was carried out for a few nozzle heights over the ground board corresponded to the engine installing heights of the aircraft. There are considerable differences in the ratio of inertia to buoyant forces in the jet between the engine operating modes, i.e., in takeoff mode (TO) the inertia is dominant, while the buoyancy is dominant in idling mode (ID). These typical conditions of TO and ID modes were examined and the results are compared with each other and with those of field test. The source position of atmospheric turbulent diffusion after the jet dispersion is estimated from these results. Author

A86-21896#
'SMART' ENGINE COMPONENTS - A MICRO IN EVERY BLADE?
A. H. EPSTEIN (MIT, Cambridge, MA) Aerospace America (ISSN 0740-722X), vol. 24, Jan. 1986, p. 60-62, 64.

'Smart' gas turbine engine technology applies feedback control to the adaptive variation of component settings in changing local conditions; as in any closed loop control system, the smart engine employs sensors, processors, and actuators. Near-term applications of these principles encompass active control of blade tip clearances and active exhaust nozzle position improvement. Longer-term applications extend to active compressor inlet distortion control, active stall alleviation of compressor flow, and active noise control. Hot section smart features may be very long term design concerns, focusing on turbine blade stress or temperature distribution. O.C.

A86-22018#
FUEL PROPERTY EFFECTS UPON EXHAUST SMOKE AND THE WEAK EXTINCTION CHARACTERISTICS OF THE PRATT AND WHITNEY PT6A-65 ENGINE
P. SAMPATH, M. GRATTON (Pratt and Whitney Canada, Mississauga), D. KRETSCHMER, and J. ODGERS (Universite Laval, Quebec, Canada) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 7 p. Research supported by the Department of National Defence, Department of Regional Industrial Expansion, Pratt and Whitney Canada, and USAF. refs
(ASME PAPER 85-GT-27)

The present paper is concerned with tests involving the use of 10 different fuels in a gas generator. These tests formed part of an investigation of the performance characteristics of small gas turbine combustors, taking into account broadened specification and alternate source fuels. Attention is given to combustor and test equipment, the measurement of exhaust carbon, smoke number relationships, the soot dependence upon air-fuel ratio data, the effect of hydrogen content upon exhaust soot, predictions for the considered engine, carbon formation as a function of engine conditions, and weak extinction characteristics. A correlation parameter which is capable of predicting the effects of different fuels upon the smoke number of several gas turbine engines is presented along with a parameter for predicting weak extinction characteristics. G.R.

A86-22024#
DESIGN OF COMBUSTOR COOLING SLOTS FOR HIGH FILM EFFECTIVENESS. I - FILM GENERAL DEVELOPMENT
G. J. STURGESS (United Technologies Corp., Engineering Div., East Hartford, CT) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 7 p. refs
(ASME PAPER 85-GT-35)

It is pointed out that in the main combustion chamber of the gas turbine engine the metal liners forming the combustor have to be provided with some form of thermal protection from the high temperatures of the reacting mixture contained therein. An established technique involves injection of a coolant along the outer surface of the component. This approach is referred to as film cooling. For aircraft gas turbines the protective medium is air, although relatively thin thermal barrier coatings are now a frequent additional feature. The devices for introducing cooling air along the liner surface are called slots. In the present paper heuristic arguments are used to derive a dimensionless grouping of internal geometric parameters which describe the lateral or circumferential uniformity of the films produced by practical slots. Experimental data from a number of different practical slot designs are examined in terms of this geometric mixing parameter. It is shown that the film effectiveness depends on this parameter over a wide range of axial distances and film blowing ratios. G.R.

A86-22025#
DESIGN OF COMBUSTOR COOLING SLOTS FOR HIGH FILM EFFECTIVENESS. II - FILM INITIAL REGION
G. J. STURGESS and G. D. PFEIFER (United Technologies Corp., Engineering Div., East Hartford, CT) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 9 p. refs
(ASME PAPER 85-GT-36)

A heuristically based geometric grouping has been used to relate the geometry of practical film cooling slots of gas turbine engine combustors to the circumferential uniformity of axial velocity in the film and the average film effectiveness. To be satisfactory, the cooling performance of a slot has been shown to require a low value of this group. A study of film development has been extended to the initial region of the film where cooling performance is at its maximum. It is demonstrated that such a region exists for both practical slots and idealized two-dimensional slots, but that the character of the initial region flow is completely different for practical slots and cannot be described by the same methods as can be used for two-dimensional slots. Author

A86-22028#
THE EFFECT OF FUEL COMPOSITION UPON COMBUSTION PERFORMANCE IN A ROLLS ROYCE TYNE COMBUSTOR
T. T. BOWDEN and J. H. PEARSON (Shell Research, Ltd., Thornton Research Centre, Chester, England) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 7 p. Research supported by the Ministry of Defence of England. refs
(ASME PAPER 85-GT-39)

The combustion performance of a wide range of fuel types has been examined utilizing a single combustor from a Tyne gas-turbine engine. The results provide further evidence to suggest that fuel total hydrogen content provides a better indication of fuel combustion performance than does aromatic content. However, an even better prediction of fuel combustion performance is given by smoke point, although the acknowledged imprecision of the smoke point test does militate against its use as a primary specification requirement. Analysis of certain fuels by (C-13) nuclear magnetic resonance and low resolution mass spectroscopy demonstrates that it is those fuels with high concentrations of polycyclic aromatic whose combustion performance, in terms of flame radiation and exhaust emissions, is underpredicted by fuel total hydrogen content. There are indications that low concentrations of high molecular weight polycyclic aromatics may substantially impair combustion performance. Author

A86-22029#
COLD FLOW AND COMBUSTION EXPERIMENTS WITH A NEW BURNER AIR DISTRIBUTION CONCEPT
B. J. JOHNSON (United Technologies Research Center, East Hartford, CT), S. J. MARKOWSKI, and H. M. CRAIG (United Technologies Corp., Pratt and Whitney Div., East Hartford, CT)
ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX. Mar. 18-21, 1985. 6 p. refs
(ASME PAPER 85-GT-40)

Experiments were conducted with a JT8D-engine sized can combustor modified such that all the combustion and dilution air entered through the burner front face from a single plenum through counter-rotating annular swirlers. Cold flow experiments were conducted to visualize and to develop a mixing and recirculation flow pattern within the combustor which contained annular and central recirculation cells and featured rapid mixing in the downstream section of the combustor. Laser velocimeter measurements, downstream of the air inlet configuration used in the combustion experiments, showed the largest velocity gradients in the tangential velocity profile. Low-pressure combustion experiments were conducted with three flat spray fuel nozzle orientations and three air inlet geometries to determine the general air inlet and fuel injection characteristics required to produce acceptable combustion characteristics with the selected swirler configuration. The combustion experiments included emission, total pressure and total temperature measurements at the burner exit plane. Low emission levels and temperature pattern factors with relatively low burner pressure losses were demonstrated. Author

A86-22049#
DYNAMIC ANALYSIS OF COMPLEX COMPOSITE ROTOR SYSTEMS WITH SUBSTRUCTURE TRANSFER MATRIX METHOD
L. YAN (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 9 p.
(ASME PAPER 85-GT-74)

A substructure transfer matrix method for the dynamic analysis of multi-rotor systems and complex composite systems is presented. When calculating, the rotor system should be decomposed into several single rotor shafts (substructures). Corresponding unknown external loads and deflections are applied to the separated surfaces, rigid support sections and ball joint sections respectively to replace the original connections. According to the connective and boundary conditions of the whole rotor system, a system of equations is established, from which the frequency equation results. The calculating formulas of vibration modes and of unbalanced responses will be easily formed by linear combination method. All computations are performed with the transfer matrix method. This method is intelligible, readily programmed and much simpler than the current transfer matrix method and modal synthesis method. Author

A86-22074#
POWER DENSE GAS TURBINE APUS
C. RODGERS (Solar Turbines Inc., Turbomach Div., San Diego, CA) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 11 p. refs
(ASME PAPER 85-GT-124)

Meeting the design requirements of smaller size, lower weight, and fast stars over wider operator envelopes for next-generation auxiliary power units (APUs) may conflict with equally compelling requirements for high thermal efficiency, since optimum cycle conditions differ for maximum specific power and lowest specific fuel consumption. Attention is presently given to the design disciplines constraining power density values for small gas turbine-type APUs; centrifugal compressors with integral radial-inflow turbines are highlighted in research efforts. O.C.

A86-22075#
AN IMPROVED SIMPLE METHOD FOR DESIGNING OPTIMUM ANNULAR DIFFUSERS
R. CAI, H. JIANG, and Y. ZHU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 8 p. Research supported by the Chinese Academy of Sciences. refs
(ASME PAPER 85-GT-126)

A set of simple BASIC codes for calculating the design parameters for axial, radial, and mixed-type annular diffusers is described. The codes are a numerical version of the Mean Stream Line method developed by Wu et al. (1952) for analyzing the two-dimensional flow field in annular diffusers. The main input data for the codes are inlet geometry, the flow parameters of the diffuser, the specific heat ratio of the working fluid, and the Laval number. The codes can be run on a pocket computer within a few minutes. Some sample calculations for an axial diffuser between a gas generator and a power turbine are presented. I.H.

A86-22081*# General Electric Co., Cincinnati, Ohio.
EVALUATION OF FUEL PREPARATION SYSTEMS FOR LEAN PREMIXING-PREVAPORIZING COMBUSTORS
W. J. DODDS and E. E. EKSTEDT (General Electric Co., Aircraft Engine Business Group, Cincinnati, OH) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 5 p. refs
(Contract NAS3-22006)
(ASME PAPER 85-GT-137)

A series of experiments was carried out in order to produce design data for a premixing prevaporizing fuel-air mixture preparation system for aircraft gas turbine engine combustors. The fuel-air mixture uniformity of four different system design concepts was evaluated over a range of conditions representing the cruise operation of a modern commercial turbofan engine. Operating conditions including pressure, temperature, fuel-to-air ratio, and velocity, exhibited no clear effect on mixture uniformity of systems using pressure-atomizing fuel nozzles and large-scale mixing devices. However, the performance of systems using atomizing fuel nozzles and large-scale mixing devices was found to be sensitive to operating conditions. Variations in system design variables were also evaluated and correlated. Mixing uniformity was found to improve with system length, pressure drop, and the number of fuel injection points per unit area. A premixing system capable of providing mixing uniformity to within 15 percent over a typical range of cruise operating conditions is demonstrated. I.H.

A86-22091#
RE-ENGINING THE HARRIER
J. D. CYRUS (U.S. Navy, Naval Air Development Center, Warminster, PA) and W. M. VOWLES (Rolls Royce, Ltd., Bristol, England) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 8 p.
(ASME PAPER 85-GT-175)

During the last twenty-eight years the capabilities of the Harrier have improved markedly, due in large measure to advances in the Pegasus propulsion system. New engine models and component improvements with their increased performance and/or weight reductions have produced increased range and payload capability for the aircraft. Because the Harrier is likely to continue in use well into the next century, an engine-aircraft-mission study has been conducted to identify the potential benefits arising from replacing the existing Pegasus engine with an advanced technology engine. These studies have shown that thrust increases associated with increased technology can improve mission capability substantially; radius can be increased by as much as 50 percent on a mission with a vertical takeoff requirement. However, as takeoff constraints are relaxed, aircraft restraints limit the benefits of the advanced technology engines. Author

A86-22092#
T56 DERIVATIVE ENGINE IN THE IMPROVED E-2C
T. P. LAUGHLIN (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) and J. TOTH (Grumman Aerospace Corp., Bethpage, NY) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 9 p.
(ASME PAPER 85-GT-176)

Airborne Early Warming for the Navy fleets has been provided for the past 20 years by the E-2 Airframe/T56 engine combination. Although avionic capability has been continually updated to meet the increased threat, the airframe and powerplant have seen only minor changes. Projected mission requirements and future avionic system enhancements require payload increases being limited by the power capability of the present T56 powerplant. Of paramount importance in the E-2 carrier deck operation is the single engine rate of climb capability of the aircraft. This paper discusses the logical evolution of a replacement engine for the E-2C, a derivative T56 engine contracted and designated by the Navy as the T56-A-427, to meet the projected single engine takeoff and other mission requirements. The T56-A-427 provides 24 percent power and 13 percent fuel consumption improvements with identical installation interfaces, and substantially improves E-2C performance characteristics across the flight envelope. Furthermore, the paper shows that meeting these stringent performance requirements with a derivative engine results in a low risk development program and an engine with improved maintainability and reliability, which can capitalize on the in-place logistics support base of the T56.
Author

A86-22101#
3-D DESIGN OF TURBINE AIRFOILS
J. HOURMOUZIADIS and N. HUEBNER (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 7 p. refs
(ASME PAPER 85-GT-188)

With modern turbines operating at a high level of efficiency, sophisticated design techniques are needed for further improvements. With the aid of computers three-dimensional aspect like end wall contouring and airfoil stacking can be integrated into the design process. The possibilities presented by the latter to control reaction, loading and secondary flow effects are analyzed and compared with experimental results. The implications for the resulting airfoil geometry are shown and limitations are discussed.
Author

A86-22116#
AXIAL FLOW CONTRA-ROTATING TURBINES
J. F. LOUIS (MIT, Cambridge, MA) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985 . 9 p. refs
(ASME PAPER 85-GT-218)

Two types of contra-rotating stages are considered; the first uses guide vanes and the second is vaneless. The wheels of the first type use bladings which are mirror images of each other and they operate with inlet and outlet swirl. The second type uses dissimilar bladings in each of the two wheels with axial inlet velocity to the first wheel and axial outlet velocity for the second wheel. An analysis of their performance indicates that both types can reach stage loading coefficients comparable or larger than conventional turbines with the same number of wheels. A comparison of the contra-rotating stages with conventional ones indicate a significant stage efficiency advantage of the contra-rotating over the conventional single rotation stages due mainly to the elimination of stationary vanes. The off-design performance indicates that relative wheel speed must be controlled. The attributes of contra-rotating turbines suggest their potential use in high performance aircraft engines, in dynamic space power systems and in low speed industrial gas turbines. Author

A86-22126#
DEVELOPING CONCEPTS IN THE ROTORDYNAMIC ANALYSIS OF AERO GAS TURBINES
R. A. BELLAMY, C. P. JONSON, and R. GAFFNEY (Rolls-Royce, Ltd., Derby, England) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 10 p. refs
(ASME PAPER 85-GT-230)

Three-dimensional nonaxisymmetric finite element models of complete aircraft gas turbine engines are routinely used as a design tool by manufacturers, in order to evaluate the static and dynamic structural characteristics of novel designs. These design models yield an order of magnitude more information than earlier ones, but do not allow easy use of the former evaluation criteria because of this expanded information's greater complexity. Animation of the graphics representing model structural response has become an essential part of analyses, in order to clarify the information generated.
O.C.

A86-22136#
EVOLUTION OF THE TURBOFAN AIRCRAFT ENGINE
M. E. SHANK (United Technologies Corp., Engineering Div., West Palm Beach, FL) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 11-1 to 11-10.

The evolution of the aircraft turbofan engine is broadly outlined, starting with the earliest low bypass ratio engine most widely used in both military transport and commercial applications. The development of this engine is shown to have been critically dependent on parallel development of titanium alloys and processing. Continuing development of low bypass ratio turbofan engines for both military fighter and commercial applications is then described, along with the development of high bypass ratio engines for transport/commerical applications. Important materials, processing, and structural/design problems are described as they relate to particular engines. The paper concludes with brief look at the future of the turbofan engine.
Author

A86-22200
THE LITTLE TURBINE BUSINESS
M. HIRST Air International (ISSN 0306-5634), vol. 30, Jan. 1986, p. 22-27.

A development history is presented for small gas turbine, turbofan, and turboprop engines since the 1950s, for the cases of both military and commercial aircraft applications. Attention is given to designs that have exhibited outstanding versatility of application or exceptionally large production runs, or both. Noteworthy engines are the J85 of the F-5 series aircraft, the Marbore II, of which 4000 examples were built, the Astazou turboprop, the PT6 turboprop (whose rating has gone from an initial 500 shp to 1424 shp), and the T63 military turboshaft. Such high performance small gas turbines as those used by cruise missiles are also noted.
O.C.

A86-22679#
LIQUID FUELED SUPERSONIC COMBUSTION RAMJETS - A RESEARCH PERSPECTIVE OF THE PAST, PRESENT AND FUTURE
P. J. WALTRUP (Johns Hopkins University, Laurel, MD) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 19 p. refs
(Contract N00024-85-C-5301)
(AIAA PAPER 86-0158)

A development history is presented for research efforts in the field of liquid-fueled supersonic combustion ramjets ('scramjets'), with a view to future development trends. Major areas of intensive concern have been the design features of inlets, isolator air ducts, fuel feed/injection systems, supersonic combustor configurations, and exit nozzles. In addition to ambient temperature and cryogenic fuels, slurry fuels have been considered. It is noted that current understanding of the mechanisms governing mixing and combustion processes in supersonic streams that merge to form a free shear layer is very limited.
O.C.

N86-16222# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.
SPANWISE REDISTRIBUTION OF ENERGY AND LOSS IN AN AXIAL FLOW COMPRESSOR BY WAKE CENTRIFUGATION Final Report, 15 Sep. 1981 - 15 Mar. 1984
C. W. WHITFIELD and J. S. KEITH May 1985 119 p
(Contract F33615-81-C-2090)
(AD-A159312; R84AEB460; AFWAL-TR-84-2109) Avail: NTIS HC A06/MF A01 CSCL 20D

The objective of this program was to develop and codify a method for predicting the spanwise redistribution of energy and loss associated with rotor/stator wakes in an axial-flow compressor. The mechanisms considered were: (1) spanwise transport of wake fluid due to imbalance of the radial pressure gradient; and (2) accumulation/dilution of wake fluid at the inner and outer casing. The work consisted of developing computer modules that perform the above defined objectives. This report describes mathematical formulas derived for definition of the peak radial and streamwise velocity decrements/increments in a wake at a blade trailing edge and their decay with downstream distance. Comparisons with data show good agreement in most cases. In addition, the thickness, displacement thickness, and momentum thickness of the wake were calculated and used in the prediction of changes in the circumferential average flow solution caused by the migration of wake fluid across streamlines. GRA

N86-16223# Rolls-Royce Ltd., Derby (England).
THE MECHANICAL DESIGN OF GAS TURBINE BLADING IN CAST SUPERALLOYS
A. G. DODD 27 Feb. 1985 47 p refs
(PNR-90247) Avail: NTIS HC A03/MF A01

The methods used for the mechanical design of hot gas turbine blading are discussed. A rapid mechanical assessment, done before the design proceeds further, is examined. The method gives an outline of the design specifying material choice, rim load on disks, cross sectional areas and mean level of cooling technology. Failure modes are discussed. It is suggested that they can be overcome by choosing a temperature and stress for each radial position. Blades are optimized by varying the required cooling technology or by changing the cross-sectional areas. Author (ESA)

N86-16224# Rolls-Royce Ltd., Derby (England). Mechanical Technology Dept.
AN ANALYSIS OF RIG TEST DISC FAILURES
G. ASQUITH 23 Jul. 1985 10 p refs
(PNR-90276) Avail: NTIS HC A02/MF A01

Life prediction criteria for hot gas turbine engine disks are examined. Safety is taken as the prime requirement in turbine design. Factors influencing the total life, and the prediction methods available are discussed. Engine size disk testing to cracking and failure is seen as the most reliable. This is equivalent to the mathematical Monte Carlo analysis. The tests also show which variables are most likely to be significant. Author (ESA)

N86-16225# Rolls-Royce Ltd., Derby (England).
CERTIFICATION OF AEROENGINES FITTED WITH FULL AUTHORITY DIGITAL CONTROL
V. A. FISHER 23 Jul. 1985 24 p Presented at Certification of Aerospace Propulsion Systems Seminar, Bangalore, India, 6-7 Mar. 1985
(PNR-90287) Avail: NTIS HC A02/MF A01

The problem of certifying electronic control systems as part of the aircraft engine is discussed. The certification is divided into verification and validation of the software and the hardware. Hardware testing includes environmental aspects such as temperature, vibration, electromagnetic compatibility, shock, sand and dust. Software by its very nature can only be presented to human perception by means of documentation. Author (ESA)

N86-16226# Rolls-Royce Ltd., Derby (England).
IS THE TRADITIONAL 150 HOUR ENDURANCE TEST OUTDATED?
R. EBBS 23 Jul. 1985 30 p Presented at Certification of Aerospace Propulsion Systems Seminar, Bangalore, India, 6-7 Mar. 1985
(PNR-90288) Avail: NTIS HC A03/MF A01

Qualification tests necessary for the granting of aircraft engine type approval are discussed. The evolution of the 150 hr test is described. The shortcomings of these tests are analyzed, together with attempts to modify the tests to be more representative. The direction which the formal requirements are likely to take in the future is considered. Author (ESA)

N86-16227# European Space Agency, Paris (France).
HOT CORROSION IN AIRCRAFT ENGINES
H. J. RETZER-SCHEIBE Feb. 1985 242 p refs Transl. into ENGLISH of "Heissgaskorrosion in Flugtriebwerken" Cologne, West Germany, 1984 Original report in GERMAN previously announced as ESA-92820
(ESA-TT-887; DFVLR-MITT-84-04) Avail: NTIS HC A11/MF A01; original German version available from DFVLR, Cologne DM 67

Hot corrosion behavior of high temperature materials, in particular heat resistant alloys used in aircraft gas turbines is reviewed. Corrosion phenomena of Ni-base and Co-base alloys were examined by burner rig tests, and protective coating systems were studied. It is found that the alloying constituents Cr, Ti, and Y improve the hot corrosion resistance while Fl, Mo, and W deteriorate the sulfurization resistance. Author (ESA)

N86-17355# Washington Univ., St. Louis, Mo. School of Engineering and Applied Science.
EFFECT OF DYNAMIC STALL AND ELASTIC PARAMETERS ON THE FUNDAMENTAL MECHANISMS OF HELICOPTER VIBRATIONS Final Report, 1 Sep. 1983 - 31 Aug. 1985
D. A. PETERS 1 Sep. 1985 11 p
(Contract DAAG29-83-K-0133)
(AD-A160022; ARO-20538.3-EG) Avail: NTIS HC A02/MF A01 CSCL 20K

This research dealt with the modeling and solution of rotary-wing dynamics. In the modeling area, it deals with elastic-blade models, ways to introduce rotor-body coupling, aerodynamic behavior near blade-tips, and the modeling of dynamic stall. In solution strategies, we have concentrated on new and improved Floquet methods, on innovative trim methodologies (such as auto-pilot and periodic shooting), on efficient formulation of equations, and on lifting-line and lifting-surface meshes. GRA

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A86-19728*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
DYNAMICS AND CONTROLS FLIGHT TESTING OF THE X-29A AIRPLANE
J. GERA (NASA, Flight Research Center, Edwards, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(AIAA PAPER 86-0167)

A brief description of the flight control system of the X-29A forward-swept-wing flight demonstrator is followed by a discussion of the flight test techniques and procedures in the area of flight dynamics and control. These techniques, which evolved during the initial few months of flight testing, are based on integrating flight testing with simulation and analysis on a flight-by-flight basis.

A limited amount of flight test results in dynamic stability and handling qualities is also presented. Author

A86-19729#
USE OF DIFFERENTIAL LEADING EDGE FLAPS FOR LATERAL CONTROL AT HIGH ANGLE OF ATTACK
D. T. WARD and L. J. STOUT (Texas A & M University, College Station) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. Research sponsored by the General Dynamics Corp. and Texas A & M University. refs
(AIAA PAPER 86-0168)

The use of differential leading-edge flaps (DLEF's) in providing roll control at high angles of attack on a high-performance fighter configuration was investigated by conducting a series of wind tunnel (WT) tests and six-degree-of-freedom simulations. The WT tests, performed on a GD/FW WT model planform, were primarily concerned with determining the roll control effectiveness with outboard ailerons, DLEFs, and trailing-edge flaps (flaperons) compared at angles of attack of 30 to 40 deg. A realistic flight control system model (EASY 4) was combined with the TW test database to generate a computer simulation (CS). The CS was validated by comparison with flight test data for a similar aircraft. The CS time histories showed that, even at a low dynamic pressure of 25 psf, a roll rate of up to 50 deg/s can be developed between 30 and 40 deg angles of attack. At a dynamic pressure of 200 psf, estimated roll rates of about 90 deg/s were generated. I.S.

A86-19818*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EXPERIMENTAL STUDY OF EFFECTS OF FOREBODY GEOMETRY ON HIGH ANGLE OF ATTACK STATIC AND DYNAMIC STABILITY
J. M. BRANDON and L. T. NGUYEN (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. refs
(AIAA PAPER 86-0331)

A series of low speed wind tunnel tests on a generic fighter model with a cylindrical fuselage were made to investigate the effects of forebody shape on static and dynamic lateral/directional stability. Five forebodies, including a chine nose of unconventional cross-sectional shape, were tested. Conventional force tests were conducted to determine static stability characteristics and single degree-of-freedom free-to-roll tests were used to study the wing rock susceptibility of the model with the various forebodies. Flow visualization data were obtained to aid in analysis of the complex flow phenomena involved. The results show that forebody cross-sectional shape can strongly effect both static and dynamic (roll) stability at high angles of attack. Large variations in stability were obtained for the various forebody geometries. These characteristics result from the impact of cross-sectional shape on forebody vortex development, the behavior of the vortices at sideslip conditions, and their interaction with the wing and empennage flow fields. Author

A86-19819*# Vigyan Research Associates, Inc., Hampton, Va.
EXPLORATORY INVESTIGATION OF DEFLECTABLE FOREBODY STRAKES FOR HIGH ANGLE OF ATTACK YAW CONTROL
D. M. RAO (Vigyan Research Associates, Inc., Hampton, VA) and D. G. MURRI (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p.
(AIAA PAPER 86-0333)

A deflectable strake concept was investigated on a conical forebody to evaluate its yaw control potential at high angles of attack. In exploratory low-speed tunnel tests using a generic delta wing fighter configuration, antisymmetrically deflected strakes provided useful levels of yaw power at angles of attack when the conventional rudder became totally degraded. Symmetrical strakes prevented side force development at high angles of attack, and provided pitch control through symmetrical deflection. The strake performance was sensitive to its circumferential position on the forebody due to varying interaction of strake vortices with the wing and vertical tail. The low Reynolds number results of this study provided a favorable initial validation of the concept, subject to verification in regard to scale effects. Author

A86-19820*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
A FLIGHTPATH OVERSHOOT FLYING QUALITIES METRIC FOR THE LANDINIG TASK
D. T. BERRY (NASA, Flight Research Center, Edwards, CA) AIAA, Aerosapce Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p.
(AIAA PAPER 86-0334)

An analysis was conducted of the attitude and flightpath angle response of configurations used in the Total In-Flight Simulator (TIFS) pitch-rate command systems program. The resutls show poor correlation between pilot ratings and attitude response and indicate that attitude was not a major influence in the results. A strong correlation was found to exist, however, between the amount of fightpath angle peak overshoot and the pilot ratings. This correlation is similar to the best correlations that have been obtained in recent closed-loop and time-domain analyses but has the advantage of greatly simplified implementation and interpretation. Author

A86-19902#
USE OF SIMULATION DURING PRELIMINARY DESIGN OF THE V-22 OSPREY
N. N. BATRA, L. W. DOOLEY (Bell Helicopter Textron, Inc., Fort Worth, TX), T. A. SHEEHAN, and K. W. GOLDSTEIN (Boeing Vertol Co., Philadelphia, PA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 8 p. refs
(AIAA PAPER 86-0491)

This paper describes the use of piloted simulation during preliminary design of the first operational tilt rotor aircraft. The develeopment and validation of a generic tilt rotor simulation program and its application towards development of the control laws, selection of the pilot's control system, and early evaluation of the handling qualities are discussed. Specific simulation tasks designed to exercise the tilt rotor's characteristics under operating conditions are described. The average handling qualities ratings for the simulated tasks from seven pilots show that the basic aircraft, without the AFCS, will meet Level 2 criteria and, when augmented by the AFCS, will meet Level 1 criteria. Author

A86-19903#
INVESTIGATION OF AIRCRAFT DEPARTURE SUSCEPTIBILITY USING A TOTAL-G SIMULATOR
G. R. RHODESIDE (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p. refs
(AIAA PAPER 86-0492)

An assembly of generic aircraft configurations have been tested for their departure and spin susceptibility and their high angle of attack flying qualities using the Naval Air Development Center's (NADC) Dynamic Flight Simulator (DFS). The DFS produces the total-G environment needed to replicate actual flight. It does this because it harnesses the vector and angular accelerations provided by NADC's three-degree-of-freedom centrifuge. An elegant control algorithm takes pilot inputs and orients and accelerates the DFS cockpit in such a manner as to yield a high level of flight fidelity. Static lateral-directional stability derivatives and inertias were varied in the experiment so as to examine the departure criteria under question (Cn-beta DYNAMIC and Lateral Control Departure Parameter, LCDP) thus providing information which will be used to develop a design guide or specification. Analysis shows the departure regions defined by Cn-beta DYN and LCDP are a good indication of departure flying qualities in the high angle of attack realm. An updated, more objective departure rating scale has been devised based on considerations of this experiment. Author

A86-19905#
AN ENGINEERING SIMULATION OF THE BOEING 747 PRIMARY FLIGHT CONTROL SYSTEMS
H. H. STRAUB (Boeing Commercial Airplane Co., Seattle, WA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 7 p.
(AIAA PAPER 86-0494)

A high-fidelity force-input simulation of the primary flight control systems of a 747 commercial aircraft is described. The performance characteristics of the major hardware components (pilot and copilot control, cable systems hydraulic actuator, and linkages) were modeled in detail, and minor modifications were incorporated to achieve a satisfactory match to aircraft ground test data. The simulation can be run in real time on an analog computer without integration problems and can be used as an engineering tool for the evaluation of hardware modifications to both the manual and autopilot control paths. The simulated flight control data are given together with ground test results in dynamic and static test conditions. A block diagram describing the simulation approach is provided. I.H.

A86-20236*# Minnesota Univ., Minneapolis.
DESIGN OF AN ACTIVE FLUTTER SUPPRESSION SYSTEM
B. S. LIEBST, W. L. GARRARD (Minnesota, University, Minneapolis), and W. M. ADAMS (NASA, Langeley Research Center, Hampton, VA) (Guidance and Control Conference, Seattle, WA, August 20-22, 1984, Technical Papers, p. 222-232) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Jan.-Feb. 1986, p. 64-71. Previously cited in issue 21, p. 2998, Accession no. A84-43425. refs
(Contract NAG1-217)

A86-20237*# Grumman Aerospace Corp., Bethpage, N.Y.
CONTROL OF A FORWARD-SWEPT-WING CONFIGURATION DOMINATED BY FLIGHT DYNAMIC/AEROELASTIC INTERACTIONS
M. RIMER, R. CHIPMAN, and B. MUNIZ (Grumman Aerospace Corp., Bethpage, NY) (Guidance and Control Conference, Seattle, WA, August 20-22, 1984, Technical Papers, p. 212-221) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Jan.-Feb. 1986, p. 72-79. Previously cited in issue 21, p. 2998, Accession no. A84-43424. refs
(Contract NAS1-17102)

A86-21318
FLIGHT STABILITY AND CONTROLLABILITY. II - AIRCRAFT LONGITUDINAL STABILITY [STABILNOST I UPRAVLJIVOST LETELICA. II - UZDUZNA STABILNOST AVIONA]
M. NENADOVIC (Beograd, Univerzitet, Belgrade, Yugoslavia) Belgrade, Masinski Fakultet Univerziteta u Beogradu, 1985, 727 p. In Serbo-Croatian. refs

Various aspects of aircraft static and dynamic longitudinal stability and control are covered in this textbook, with the appropriate equations presented. Reference is made to maneuverability and control surface strength criteria for large aircraft, static longitudinal stability in relation to trim and control forces, and the effects of fuselage flexibility on longitudinal stability and control. B.J.

A86-21840#
A REDUNDANT STRAPDOWN REFERENCE FOR ADVANCED AIRCRAFT FLIGHT CONTROL SYSTEMS
L. CAMBERLEIN and P. NICAISE (Societe d'Applications Generales d'Electricite et de Mecanique, Paris, France) IN: Symposium Gyro Technology 1984; Proceedings of the Symposium, Stuttgart, West Germany, September 11, 12, 1984 . Stuttgart/Duesseldorf, Universitaet Stuttgart/Deutsche Gesellschaft fuer Ortung und Navigation, 1984, p. 15.0-15.27.

This paper shows the advantage of the skewed axis redundancy and of two-axis dry tuned gyros for providing electric flight control systems with a strapdown reference. It describes the theoretical features of the skewed axis redundancy and provides the results of laboratory tests performed on the development system MSDO3. As a conclusion, the article describes a reference, for fighter aircraft flight control systems, that provides, in addition, backup attitude and navigation. Author

A86-21900#
TALKING TO YOUR AIRCRAFT
E. J. LERNER Aerospace America (ISSN 0740-722X), vol. 24, Jan. 1986, p. 84-86, 88.

The most promising development trends and performance capability prospects for cockpit control voice recognition systems are considered, with attention to the solution of the problems of contextuality that inhere in the semantics of spoken languages. The recognition of speech in the high stress and frequently noisy environment of military aircraft cockpits presents especially troublesome design problems. Emphasis is on the recognition of commands for the execution of a given task that may be couched in very different sentences by the same pilot at different times. O.C.

A86-22309#
TERRAIN FOLLOWING AVOIDANCE TECHNIQUE OF VERY LOW ALTITUDE PENETRATION
Y. ZHENG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, Aug. 1985, p. 313-320. In Chinese, with abstract in English. refs

Aircraft guidance in very low altitude penetration, especially the terrain-following technique, is addressed. The development of the latter technique from the early N method to the modern adaptive angle method, as well as the optimal control method now under development, is reviewed. Recent progress in this field, such as terrain storage, combined terrain following, and terrain avoidance technique, among others, is introduced. C.D.

A86-22317#
GUST ALLEVIATION USING COMBINED CONTROL LAWS
J. CHANG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, Aug. 1985, p. 379-384. In Chinese, with abstract in English.

An analytical method of gust alleviation and other active control purposes (relaxed static stability, etc.) for an airplane is described. Gust alleviation uses direct measurements of atmospheric turbulence to yield a feed-forward or open-loop control law. It is relatively insensitive to changes in flight conditions. Thus a combined control law can be obtained which contains feed-back and feed-forward components. The stability of the gust alleviation system and the performances of other active control purpose can be satisfied by obtaining a linear optimal control defined by a quadratic performance index. Thus the performance index is combined, and the optimal feed-back control law is straightforward and well-known. An application of the combined control law to a flexible airplane is presented. Calculations have been performed to obtain the normal acceleration responses of the airplane to the turbulence and the state responses for the other active control purpose. Author

N86-16228*# *Connecticut Univ., Storrs.*
AN INVESTIGATION OF ADAPTIVE CONTROLLERS FOR HELICOPTER VIBRATION AND THE DEVELOPMENT OF A NEW DUAL CONTROLLER Final Report
P. MOOKERJEE, J. A. MOLUSIS, and Y. BAR-SHALOM Jan. 1985 162 p refs
(Contract NAG2-213)
(NASA-CR-177377; NAS 1.26:177377) Avail: NTIS HC A08/MF A01 CSCL 01C

An investigation of the properties important for the design of stochastic adaptive controllers for the higher harmonic control of helicopter vibration is presented. Three different model types are considered for the transfer relationship between the helicopter higher harmonic control input and the vibration output: (1) nonlinear; (2) linear with slow time varying coefficients; and (3) linear with constant coefficients. The stochastic controller formulations and solutions are presented for a dual, cautious, and deterministic controller for both linear and nonlinear transfer models. Extensive

simulations are performed with the various models and controllers. It is shown that the cautious adaptive controller can sometimes result in unacceptable vibration control. A new second order dual controller is developed which is shown to modify the cautious adaptive controller by adding numerator and denominator correction terms to the cautious control algorithm. The new dual controller is simulated on a simple single-control vibration example and is found to achieve excellent vibration reduction and significantly improves upon the cautious controller. Author

N86-16229# European Space Agency, Paris (France).
FLIGHT DYNAMICS AND AIRCRAFT PILOTING
J. C. WANNER May 1985 419 p refs Transl. into ENGLISH of "Dyn. du Vol et Pilotage des Avions" ONERA-P-1983-1 Paris, France, 1983 Revised
(ESA-TT-874; ONERA-P-1983-1; ONERA-P-1976-6-REV) Avail: NTIS HC A18/MF A01

The principle of piloted vehicle mechanics is presented, and aircraft longitudinal movement is studied. Assuming that the pilot counters with his lateral controls any sideslip, and that the aircraft plane of symmetry is vertical, the trajectory is described in that same vertical plane. The natural modes (angle of attack oscillation, phugoid, aperiodic motion) of the small movements around straight and level flight, the response to the pilots commands, and equilibrium stability, are examined. Small lateral movements around straight and level flight and the aircraft response to lateral controls are considered. Small movements of the aircraft around stabilized level flight in rotation are also examined. The assumptions of separation of longitudinal and lateral movements around stabilized straight and level flight are validated. Author (ESA)

N86-17357 Engineering Sciences Data Unit, London (England).
ESTIMATION OF SIDEFORCE, YAWING MOMENT AND ROLLING MOMENT DERIVATIVES DUE TO RATE OF YAW FOR COMPLETE AIRCRAFT AT SUBSONIC SPEEDS
Apr. 1984 52 p refs Submitted for publication
(ESDU-84002; ISBN-0-85679-463-5; ISSN-0141-397X) Avail: ESDU

ESDU 84002 demonstrates how methods given elsewhere in the Sub-series for estimating the contributions to the derivatives Y sub r, N sub r and L sub r due to individual major parts of the airframe (wing, bodies, flaps and fin) may be combined to provide values for the complete aircraft. The overall accuracy achieved is illustrated by correlation plots showing comparison of prediction with flight test and wind tunnel results drawn from many sources in the literature; for a diverse range of configurations broadly Y sub r is predicted within 0.05, N sub r within 0.025 and L sub r within 0.02. A simplified method for estimating complete aircraft yawing derivative values is also included. Author

N86-17358*# Kansas Univ., Lawrence. Flight Research Lab.
DEVELOPMENT OF A SENSITIVITY ANALYSIS TECHNIQUE FOR MULTILOOP FLIGHT CONTROL SYSTEMS Final Report
A. H. VAILLARD, J. PADUANO, and D. R. DOWNING Oct. 1985 162 p refs
(Contract NCC2-293)
(NASA-CR-166619; NAS 1.26:166619) Avail: NTIS HC A08/MF A01 CSCL 01C

This report presents the development and application of a sensitivity analysis technique for multiloop flight control systems. This analysis yields very useful information on the sensitivity of the relative-stability criteria of the control system, with variations or uncertainties in the system and controller elements. The sensitivity analysis technique developed is based on the computation of the singular values and singular-value gradients of a feedback-control system. The method is applicable to single-input/single-output as well as multiloop continuous-control systems. Application to sampled-data systems is also explored. The sensitivity analysis technique was applied to a continuous yaw/roll damper stability augmentation system of a typical business jet, and the results show that the analysis is very useful in determining the system elements which have the largest effect on the relative stability of the closed-loop system. As a secondary product of the research reported here, the relative stability criteria based on the concept of singular values were explored. B.W.

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A86-19324
THE NEW 'DUAL STAGE' TEST PROCEDURE FOR LOW COST MEASUREMENT OF PARACHUTE PERFORMANCE
R. W. HUNTER (U.S. Navy, Naval Weapons Center, China Lake, CA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 157-160.

The Parachute Service Life Extension Program represents a joint Navy and Air Force program which was initiated in 1983 with the aim to establish scientifically-based service and storage lives for personnel parachutes. The criteria selected for establishing the optimum service and storage lives are related to age-caused changes in parachute reliability and material properties. In order to determine the number of tests (per parachute type) required to statistically measure the effects of aging on reliability, a test plan was prepared. In accordance with this plan, 280 reliability tests were initially scheduled for Fiscal Year 1984. The two standard test procedures considered for the reliability tests are discussed, taking into account certain problems. As a solution to these problems, a dual stage test procedure was developed. This procedure consists of two parts, including a descent rate measurement test and a parachute stress test. G.R.

A86-19328
BALLISTIC GAS FIRED DEVICES
P. MILCETIC (U.S. Navy, Naval Ordnance Station, Indian Head, MD) and M. SCHIMMEL (McDonnell Aircraft Co., St. Louis, MO) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 179-182. refs

The Naval Ordnance Station has conducted a program researching the feasibility of using hot gases from a standard initiator to ignite an explosive train, with an output which initiates percussion primers. This technique eliminates parts required in standard firing mechanisms, including the firing pin, O-ring seal, and shear pin. This allows redundant primers to be incorporated into an existing single primer firing mechanism without changing the exterior envelope. One hundred and six 'breadboard' tests were conducted over the temperature range of -65 F to +165 F, using various ballistic hose configurations, including simulation of specific aircraft escape systems. The feasibility and reliability of this technique is examined by analyzing the test results. Application of this design to other escape system devices is also discussed in this paper. Author

A86-19340
DEVELOPMENT OF A GENERALIZED ESCAPE SYSTEM SIMULATION COMPUTER PROGRAM
L. A. DAULERIO (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) and D. A. FENDER (Ketron, Inc., Warminster, PA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 246-250. refs

It is pointed out that the development of escape systems for safely ejecting crewmembers from high performance military aircraft is a complex and demanding task. For this reason, the U.S. Navy has based research for the improvement of escape systems partly on the mathematical simulation of the operation of such systems. The present paper is concerned with the development of a

simulation model which has now become known as the Generalized Escape System. Simulation (GESS) program. The GESS program divides the ejection sequence into three primary phases. The model is based upon the numerical integration of the six degree-of-freedom equations of motion for each of four basic program elements. Development issues are discussed, taking into account coordinate systems and transformations, aerodynamic coefficients, computational considerations, the dynamic center of gravity, the user interface, and aspects of verification. G.R.

A86-19703#
REFLECTIONS REGARDING RECENT ROTARY RIG RESULTS
L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 8 p. refs
(AIAA PAPER 86-0123)

Recent rotary rig experiments are examined to evaluate how well they simulate dynamic conditions existing in full scale flight. It is found that most rig designs used are prone to cause significant interference with the vortex wake shed from an advanced aircraft at high angles of attack. The support interference problem can be aggravated substantially by the coupling existing in the critical Reynolds number range between vehicle motion and boundary layer transition, a coupling that is unlikely to have been simulated in most wind tunnel tests. Author

A86-19727*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
THE ROLE OF A REAL-TIME FLIGHT SUPPORT FACILITY IN FLIGHT RESEARCH PROGRAMS
A. L. MOORE (NASA, Flight Research Center, Edwards, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p.
(AIAA PAPER 86-0166)

This paper presents some of the approaches taken by the NASA Western Aeronautical Test Range (WATR) of Ames Research Center to satisfy the ever-increasing real-time requirements of research projects such as the F-14, F-15, advanced fighter technology integration (AFTI) F-16, YAV-88, and the X-29A. The approaches include the areas of data acquisition, communications (video and audio), real-time processing and display, data communications, and tracking. Author

A86-22188
FACILITY FOR CLOSED LOOP TESTING OF AIRCRAFT CONTROL SYSTEMS
J. BLAETZ (McDonnell Aircraft Co., St. Louis, MO) IN: Environmental integration technology today for a quality tomorrow; Proceedings of the Thirtieth Annual Technical Meeting, Orlando, FL, May 1-3, 1984 . Mount Prospect, IL, Institute of Environmental Sciences, 1984, p. 319-321.

Improvements in aircraft performance have brought the need for more precise testing of flight control systems prior to flight. McDonnell Aircraft Company has developed a flight control system functional mockup for the AV-8B Harrier II to perform tests on the completely integrated aircraft flight control system. A high-speed digital computer incorporated into the functional mockup permits testing of the flight control system in real time. The computer, employing parallel processors, solves the non-linear equations of motion that describe the aircraft's six degrees of freedom. This paper describes the computer system, its programming, and the interfacing of the computer with the functional mockup. The paper also discusses the functional mockup design, instrumentation, and data collection and analysis. Typical test operations on the flight control systems are also described. Author

A86-22189
PERFORMANCE OF AV-8B HARRIER II STRUCTURAL TEST PROGRAM
J. V. MURPHY, D. E. SCHNORING, and H. C. TOURKAKIS (McDonnell Aircraft Co., St. Louis, MO) IN: Environmental integration technology today for a quality tomorrow; Proceedings of the Thirtieth Annual Technical Meeting, Orlando, FL, May 1-3, 1984 . Mount Prospect, IL, Institute of Environmental Sciences, 1984, p. 322-327.

As part of the AV-8B Harrier II Full-Scale Development Program, a structural test program, including both static and fatigue tests, was conducted from 1981 through 1983. The program was satisfactorily completed, within cost and on schedule, which attests to the high efficiency of the structure. The static tests related to the flight placards were completed ahead of schedule, as desired, and the two-lifetime fatigue test was also completed early. This paper describes how the combined efforts of NAVAIR and MCAIR led to the accomplishment of the program objectives. It also illustrates that the success of the program was a function of advance planning, effective communications, in-depth status monitoring, and maintaining basic program objectives. Author

A86-22687*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
SIMULATION AND ANALYSIS OF NATURAL RAIN IN A WIND TUNNEL VIA DIGITAL IMAGE PROCESSING TECHNIQUES
K. M. AARON, M. HERNAN, P. PARIKH, V. SAROHIA (California Institute of Technology, Jet Propulsion Laboratory, Pasadena), and M. GHARIB (California, University, La Jolla) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 6 p. refs
(Contract NAS7-918; NASA ORDER RE-65-459; NASA TASK 505-45-00-04-59)
(AIAA PAPER 86-0291)

It is desired to simulate natural rain in a wind tunnel in order to investigate its influence on the aerodynamic characteristics of aircraft. Rain simulation nozzles have been developed and tested at JPL. Pulsed laser sheet illumination is used to photograph the droplets in the moving airstream. Digital image processing techniques are applied to these photographs for calculation of rain statistics to evaluate the performance of the nozzles. It is found that fixed hypodermic type nozzles inject too much water to simulate natural rain conditions. A modification uses two aerodynamic spinners to flex a tube in a pseudo-random fashion to distribute the water over a larger area. Author

N86-16230 Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost.
SIMULATION OF A SIX DEGREES OF FREEDOM FLIGHT SIMULATOR MOTION SYSTEM
G. J. WIERDA 1 May 1982 47 p refs
(UA-00-39) Avail: Issuing Activity

A model of a single hydraulic actuator and controller developed to investigate nonlinearities in the servo valve transfer function to limit the amount of hardware in the simulation, was simplified by linearizing the square roots in the pressure-flow relationship. Six of the simplified models were coupled to obtain a simulation model of a complete six degrees of freedom motion system. A transformation and mass matrix to describe the dynamic equations were calculated for a motion system. Simulation results indicate high underdamped frequency components in the acceleration response of the actuators. It is shown that acceleration feedback rather than force feedback is preferred to damp the high frequency components. Author (ESA)

N86-16232*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STUDY OF ICE ACCRETION ON ICING WIND TUNNEL COMPONENTS
J. E. NEWTON and W. OLSEN 1986 24 p refs Presented at the 24th Aerospace Sciences Meeting, Reno, Nev., 6-8 Jan. 1986; sponsored by AIAA
(NASA-TM-87095; E-3828; NAS 1.15:87095) Avail: NTIS HC A02/MF A01 CSCL 01E

In a closed loop icing wind tunnel the icing cloud is simulated by introducing tiny water droplets through an array of nozzles upstream of the test section. This cloud will form ice on all tunnel components (e.g., turning vanes, inlet guide vanes, fan blades, and the heat exchanger) as the cloud flows around the tunnel. These components must have the capacity to handle their icing loads without causing significant tunnel performance degradation during the course of an evening's run. To aid in the design of these components for the proposed Altitude Wind Tunnel (AWT) at NASA Lewis Research Center the existing Icing Research Tunnel (IRT) is used to measure icing characteristics of the IRT's components. The results from the IRT are scaled to the AWT to account for the AWT's larger components and higher velocities. The results show that from 90 to 45 percent of the total spray cloud froze out on the heat exchanger. Furthermore, the first set of turning vanes downstream of the test section, the FOD screen and the fan blades show significant ice formation. The scaling shows that the same results would occur in the AWT. Author

N86-16233*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PROGRESS IN THE LEWIS RESEARCH CENTER ALTITUDE WIND TUNNEL (AWT) MODELING PROGRAM
C. C. CIEPLUCH, R. R. BURLEY, D. E. GROESBECK, and J. C. MAREK 1986 19 p refs Proposed for presentation at the 14th Aerodynamic Testing Conference, West Palm Beach, Fla., 5-7 Mar. 1986; sponsored by AIAA
(NASA-TM-87194; E-2850; NAS 1.15:87194) Avail: NTIS HC A02/MF A01 CSCL 14B

The rehabilitation of the Altitude Wind Tunnel (AWT) at the NASA Lewis Research Center is under study with the goal of providing a modern subsonic wind tunnel for conducting propulsion system/airframe integration, isolated propulsion system, propulsion acoustics and adverse weather tests. Because of the increased Mach number capability (from Mach 0.6 to 0.9 plus) and the incorporation of acoustic and adverse weather capabilities into an existing tunnel, the AWT rehabilitation represents a significant technical challenge. In order to reduce the risk associated with such an undertaking, and extensive AWT modeling program is being conducted to guide and verify the tunnel design. Significant findings and progress in this modeling program are the subject of this paper. Author

N86-16235# Duits-Nederlandse Windtunnel, North East Polder (Netherlands).
GERMAN-DUTCH WIND TUNNEL (DNW). PRESENT AND FUTURE APPLICATIONS FOR INDUSTRIAL DEVELOPMENTS [DEUTSCH-NIEDERLAENDISCHER WINDKANAL (DNW). GEGENWAERTIGER UND KUENFTIGER EINSATZ FUER INDUSTRIELLE ENTWICKLUNGEN]
J. BARCHE 1983 43 p refs In GERMAN Presented at 3rd BMFT Statusseminar Luftfahrtforschung und Luftfahrttechnology, Hamburg, West Germany, 2-4 May 1983
Avail: NTIS HC A03/MF A01

The German-Dutch wind tunnel was designed to perform aerodynamic and aeroacoustic development investigations in the subsonic range. The wind tunnel is composed of closed test sections with transverse sections of 6 m x 6 m, 8 m x 6 m and 9.5 m x 9.5 m and with respective velocity of 150, 120, and 60 m/sec, and of open test sections with 8 m x 6 m entry surface and with a maximum velocity of 80 m/sec. The tunnel is applied for productive testing of aircraft, vehicles and civil engineering, for demonstration, calibration and system integration. Author (ESA)

N86-16236# Duits-Nederlandse Windtunnel, North East Polder (Netherlands).
AEROACOUSTIC CALIBRATION OF THE GERMAN-DUTCH WIND TUNNEL (DNW) OPEN JET
R. ROSS (National Aerospace Lab., Northeast Polder, Netherlands), J. W. G. VANNUNEN (National Aerospace Lab., Northeast Polder, Netherlands), K. J. YOUNG (Boeing Commercial Airplane Co., Seattle, Wash.), R. M. ALLEN (Boeing Commercial Airplane Co., Seattle, Wash.), and J. C. A. VANDITSHUIZEN 1983 102 p refs
(DNW-TR-82-03; D6-51501) Avail: NTIS HC A06/MF A01

The aerodynamic and acoustic quality of the German-Dutch Wind Tunnel open jet test section configuration was established. The flow quality is found to be excellent; for the core region angular deviations up to 0.1 deg, turbulence levels of 0.2% and dynamic pressure deviations of 0.5% are reported. Near the shear layer these values become higher. The anechoic quality meets reasonably high standards. The acoustic correction procedures for 1/3 octave analysis were checked. The usual shear layer correction has to be extended to correct for turbulence effects for high tunnel velocity, high frequency, and the most forward and the most rearward propagation angles from the sound source. This correction is independent of the position of the model in the flow and the type of sound source (tone or broadband).
Author (ESA)

N86-16237# Duits-Nederlandse Windtunnel, North East Polder (Netherlands).
ACOUSTIC EVALUATION OF THE GERMAN-DUTCH WIND TUNNEL (DNW) SHEAR LAYER CORRECTION USING A MODEL JET
W. H. HERKES (Boeing Commercial Airplane Co., Seattle, Wash.), F. G. STROUT (Boeing Commercial Airplane Co., Seattle, Wash.), R. ROSS (National Aerospace Lab., Northeast Polder, Netherlands), and J. C. A. VANDITSHUIZEN 1983 140 p refs
(DNW-TR-82-04; D6-51502) Avail: NTIS HC A07/MF A01

Acoustic tests of a 6-cm model jet were conducted in the German-Dutch Wind Tunnel 6m by 8m free jet facility to evaluate a free jet shear layer correction procedure that adds an empirical correction to the previous theoretical correction. Static-flight effects on jet noise measured in the flow were used to evaluate the corresponding out-of-flow results. The experiment demonstrates that the procedure significantly improves the accuracy of the flight effects measured by the out-of-flow microphones. Comparisons of the out-of-flow free jet results to results obtained in closed wind tunnels and from aircraft flyovers show consistent trends.
Author (ESA)

N86-16238# Duits-Nederlandse Windtunnel, North East Polder (Netherlands).
AERODYNAMICAL CALIBRATION OF THE GERMAN-DUTCH WIND TUNNEL (DNW): A REVIEW OF TESTING TECHNIQUES AND RESULTS
Feb. 1983 7 p
(DNW-PA-82062) Avail: NTIS HC A02/MF A01

System checkout, performance measurement, and aerodynamical calibration of the German-Dutch Wind Tunnel are summarized. Mechanical and electrical system tests; flow quality measurements; static and dynamic performance assessment; temperature and pressure distribution measurement; and turbulence and spectral characteristics measurement are described.
Author (ESA)

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A86-20244#
A PARALLEL QUASI-LINEARIZATION ALGORITHM FOR AIR VEHICLE TRAJECTORY OPTIMIZATION
P. K. A. MENON and L. L. LEHMAN (Integrated Systems, Inc., Palo Alto, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 9, Jan.-Feb. 1986, p. 119-121. Previously cited in issue 07, p. 862, Accession no. A85-19792. refs
(Contract F08635-83-C-0480)
(AIAA PAPER 85-0498)

N86-16243*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SUPERSONIC AERODYNAMIC CHARACTERISTICS OF SOME REENTRY CONCEPTS FOR ANGLES OF ATTACK TO 90 DEG
M. L. SPEARMAN Nov. 1985 32 p refs
(NASA-TM-87645; NAS 1.15:87645) Avail: NTIS HC A03/MF A01 CSCL 22B

Past studies of reentry vehicles tested to high angles of attack (up to 90 deg) in the Mach number range from 2 to 4.8 are reviewed. Two basic planforms are considered: highly-swept deltas and circular. The delta concepts include variations in cross section (and thus volume) and in camber distribution. The effectiveness of various types of aerodynamic control devices is also included. The purpose of the paper is to examine the characteristics of the vehicles with a view toward the potential usefulness of such concepts in a flight regime that would include reentry from space into the atmosphere followed by a transition to sustained atmospheric flight. Author

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A86-19312
A SCIENTIFIC METHOD FOR DETERMINING THE USEFUL LIFE OF EXPLOSIVE DEVICES IN AIRCRAFT
W. E. EARLY, JR. (General Dynamics Corp., Fort Worth, TX) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 81-88.

Attention is given to an effort by the F-16 System Program Office to determine the useful service life of all explosive devices encompassed by an aircraft crew escape system. This entailed both the experimental determination of the true thermal environment of these explosive devices under worst case operational conditions, and the performance of accelerated service life tests for groups of each type of device to ascertain the safe life of each under the measured conditions. O.C.

A86-19313
THE USE OF TLX ENERGY TRANSFER LINES ON THE F-16 AIRCRAFT
W. E. EARLY, JR. (General Dynamics Corp., Fort Worth, TX) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 89-94.

This paper describes TLX (Thin Layer Explosive) in the form in which it has been developed for use on the F-16 aircaft and traces its evolution from the original Swedish product. It illustrates the current applications of TLX in the F-16 and gives the reasons why it has superseded two other types of linear-explosive lines. It summarizes the design requirements established by General Dynamics and the recently completed qualification test program. It discusses some of the advantages of this new product over older types of linear-explosive products (SMDC, FCDC, etc.). In addition, it briefly describes significant informal tests performed to evaluate the safety and ruggedness of TLX. Author

A86-19349* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
APPROACH FOR SERVICE LIFE EXTENSION OF EXPLOSIVE DEVICES FOR AIRCRAFT ESCAPE SYSTEMS
L. J. BEMENT (NASA, Langley Research Center, Hampton, VA) and M. L. SCHIMMEL (McDonnell Aircraft Co., St. Louis, MO) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 334-341.

Service life extension of explosive devices used in aircraft escape systems can achieve considerable savings. An overall approach is needed to challenge the logic of explosive component service extension from design to removal from service for evaluation. The purpose of the effort described in this paper was to develop a service-extension approach on explosive devices used in aircraft systems, supported by actual testing of representative candidate devices, to evaluate quantitatively the effects of service, age, and degradation, and allow responsible, conservative service life determinations. Evaluated were five explosive components: rigid and flexible explosive transfer lines, one-way transfers, flexible linear shaped charges, and initiation handles. The service extension approach generated in this effort is summarized by eight recommendations. Author

A86-19929*# United Technologies Research Center, East Hartford, Conn.
LONG TERM DEPOSIT FORMATION IN AVIATION TURBINE FUEL AT ELEVATED TEMPERATURE
A. J. GIOVANETTI and E. J. SZETELA (United Technologies Research Center, East Hartford, CT) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p.
(Contract NAS3-24091)
(AIAA PAPER 86-0525)

An experimental characterization is conducted for the relationships between deposit mass, operating time, and temperature, in coking associated with aviation fuels under conditions simulating those typical of turbine engine fuel systems. Jet A and Suntech A fuels were tested in stainless steel tubing heated to 420-750 K, over test durations of between 3 and 730 hr and at fuel velocities of 0.07-1.3 m/sec. Deposit rates are noted to be a strong function of tube temperature; for a given set of test conditions, deposition rates for Suntech A exceed those of Jet A by a factor of 10. Deposition rates increased markedly with test duration for both fuels. The heated tube data obtained are used to develop a global chemical kinetic model for fuel oxidation and carbon deposition. O.C.

A86-20037#
RESEARCH ON HIGH-STRENGTH AEROSPACE ALUMINUM ALLOYS
J. T. STALEY (Aluminum Company of America, Alloy Technology Div., Pittsburgh, PA) (CASI, Annual General Meeting, 31st, Ottawa, Canada, May 28, 1984) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 31, March 1985, p. 14-29. refs

The utilization of aluminum alloys in airframe designs is discussed. The present aim in aircraft design is to save weight by decreasing density and increasing strength while maintaining corrosion resistance and increasing toughness, modulus, and fatigue resistance. Aluminum-lithium alloys and wrought powder metallurgy alloys are currently being studied for aircraft structures. Wrought powder metallurgy alloys have 30 percent higher strength than conventional alloys with improved toughness and corrosion. The application of dispersion hardened alloys for temperatures in the range 350-600 F and wrought powder metallurgy alloys for aircraft wheels is described. The fabrication and fatigue testing of the wrought powder metallurgy alloys are analyzed. The development of cost effective, lightweight, and resistant aircraft structures from metal matrix composites, aramid aluminum laminates, and superplastic 7475 is being investigated. I.F.

A86-20579
HIGH STRENGTH NICKEL-PALLADIUM-CHROMIUM BRAZING ALLOYS
D. BOSE, A. RABINKIN, N. J. DE CRISTOFARO (Allied Corp., Metglas Products, Parsippany, NY), and A. DATTA (EG&G Sealol, Inc., Providence, RI) Welding Journal, Research Supplement (ISSN 0043-2296), vol. 65, Jan. 1986, p. 23-s to 29-s. refs

Nickel-palladium based filler metals are investigated as possible replacements for gold-filled filler metals, such as BAu-4, used as brazing alloys for joining aircraft engine components. Like BAu-4, the brazing temperatures of the Ni-Pd alloys are below 1010 C, making them suitable for joining critical aircraft engine components made with gamma-prime hardened superalloys, such as Inconel 718. Elevated temperature mechanical properties, corrosion behavior, and microstructural characteristics of Inconel-718 joints brazed with Ni-Pd compositions and with BAu-4 alloy are found to be comparable. V.L.

A86-20636
DELAMINATION THRESHOLD AND LOADING EFFECT IN FIBER GLASS EPOXY COMPOSITE
C. BATHIAS and A. LAKSIMI (Compiegne, Universite de Technologie, France) IN: Delamination and debonding of materials . Philadelphia, PA, American Society for Testing and Materials, 1985, p. 217-237. refs

Helicopter rotor heads made of glass fiber-epoxy composite show good strength, particularly in fatigue failures. However, interlaminar defects may always grow under the effect of loading in bending. To predict the development of these plane defects, the delamination threshold and low crack growth rate were studied in double cantilever beam-type specimens calibrated by compliance. Experimentally, a delamination threshold exists below which a plane crack does not propagate, either in Mode I or Mode II testing. Fatigue loading may cause the growth of delamination between adjacent plies at a strain energy release rate Delta G(th) five times lower than the fracture energy G(c). This difference is relatively insignificant by comparison with metals, since in numerous alloys the difference can be as high as 100. This demonstrates the importance of determining a delamination threshold to evaluate the damage tolerance of the composite. Complex loadings were introduced into our tests by programming temporary overloads and sequences of loading at two stress levels during cycling. The glass fiber-epoxy composites do not show significant memory effect, but are sensitive to the load ratio R. Author

A86-21296
RECENT DEVELOPMENTS IN CARBON FIBRE COMPOSITE
J. MATSUI, T. NORITA (Toray Industries, Inc., Tokyo, Japan), and M. HIRATA (Soficar, Paris, France) SAMPE Journal (ISSN 0091-1062), vol. 21, Nov.-Dec. 1985, p. 39-44. refs

To fulfill requirements of carbon fiber composite for aircraft structures, intermediate modulus (295 GPa) and higher strength (5600 MPa) carbon fiber TORAYCA T800 was developed. T800 composite shows greatly improved composite properties dominated by fiber such as tensile modulus, compressive modulus, tensile strength without hole and with hole, and through-penetration impact load. There is no effect on transverse tensile strength, compressive strengths, and shear strength with increase of fiber properties. Status of matrix resin developments is also discussed in terms of improvements in transverse cracking and compressive strength after impact. Author

A86-21701
NATIONAL SAMPE TECHNICAL CONFERENCE, 17TH, KIAMESHA LAKE, NY, OCTOBER 22-24, 1985, PROCEEDINGS
Conference sponsored by the Society for the Advancement of Material and Process Engineering. Covina, CA, Society for the Advancement of Material and Process Engineering (National SAMPE Technical Conference Series. Volume 17), 1985, 736 p. For individual items see A86-21702 to A86-21758.

Among the topics discussed are: optically transparent silicon elastomers; bismaleimides; and the ablation characteristics of graphite/epoxy. Consideration is also given to the effects of thermal exposure on the structural and mechanical integrity of graphite fibers; processable polyimide matrix resins; biomedical electronics applications of materials characterization and analysis systems; and P/M titanium shape technology using the ceramic mold process. Additional topics discussed include: microstructure modification of Ti-6Al-4V casings; titanium castings for airframe applications; and heat treatment and forming considerations in processing aluminum-lithium alloys. I.H.

A86-21707
CAST ALUMINUM FATIGUE PROPERTY/MICROSTRUCTURE RELATIONSHIPS
P. C. INGUANTI (United Technologies Corp., Sikorsky Aircraft, Stratford, CT) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 61-72.

The relationship between the tensile properties, fatigue properties, and the microstructure are examined for two cast aluminum alloys, A201.0 and A357.0, processed by three different foundry techniques. It is shown that A201.O-T7 has consistently high tensile properties but its fatigue strength is low due to casting flaw sensitivity. The fatigue properties of the alloy, however, can be substantially improved through foundry or post-foundry techniques eliminating shrinkage porosity. A357.O-T6 castings, which are free of large shrinkage voids, are found to have the optimum combination of tensile and fatigue properties for application to fatigue loaded components. V.L.

A86-21710
OPTICALLY TRANSPARENT SILICONE ELASTOMERS
M. D. BAILE (Dow Corning Corp., Midland, MI) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 97-105. Research supported by Dow Corning Corp.

A wet process hydrophobic (WPH) silica technology is employed to prepare optically transparent silicone elastomers which embrace a unique combination of property profile. These elastomers can be cured via peroxides or hydrosilation method, in less than 30 minutes at 100 C. The unvulcanized rubber mixture can be processed easily due to its non-tacky surface and low plasticity. A wide range of mechanical properties is obtained: 25-80 Durometer, 500-1100 percent Elongation, 8.3-12.7 MPa Tensile Strength, lap shear adhesion greater than 300 psi to glass,

polycarbonate and acrylic. The optical properties are greater than 90 percent Transmission and less than 22 percent Haze for a 1.27 mm thick elastomer. The shelf life of catalyzed unvulcanized rubber mixture is seven weeks at ambient temperature and greater than seven months at 0 C. These types of elastomers can potentially satisfy important needs in the marketplace such as aircraft windshield interlayer application, thermal adsorber boiler or/photovoltaic cells, medical grade blood pump devices, catheters, elasto-optic transducers, etc. Author

A86-21719
APPLICATIONS OF TUBULAR COMPOSITE STRUCTURES
D. P. MAASS (Advanced Composite Products, Inc., East Haven, CT) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 200-208.

This paper is intended to portray the broad range of applications for tubular composite parts. These applications are organized by means of structural function (i.e. compression columns, beams, internal pressure vessels, etc.) with specific examples in each case. The parts described, cover a broad range of designs including diameters from .125-arcmin to 16-arcmin, wall thickness from .010-in. to 1-in., materials including glass, Kevlar, oriented polyethylene, and all forms of graphite fiber, solid and sandwich wall construction, etc. The tradeoffs between the various methods for fabricating composite tubes (roll wrapped prepreg, filament winding, pultrusion, braiding, etc.) are also addressed. Author

A86-21722
IMPACT OF COMPOSITE MATERIALS ON ADVANCED FIGHTERS
M. M. RATWANI (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 232-241.

The impact of composite materials on the performance, durability and life cycle costs of advanced fighter aircraft is presented in this paper. The advantages of using high strain fibers, high toughness resin and hybrids in the structural design of advanced composites are discussed. The role of stitching in retarding delamination growth in composites is shown. A brief discussion of composition repairs for combat readiness is also given. Author

A86-21726
TITANIUM NEAR NET SHAPE COMPONENTS FOR DEMANDING AIRFRAME APPLICATIONS
R. H. WITT and A. L. FERRERI (Grumman Aerospace Corp., Bethpage, NY) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 296-305. refs

This paper deals with the viability of Hot Isostatic Pressing (HIP) Near Net Shape (NNS) titanium parts in competition with forged or cast components. The paper summarizes NNS and advanced alloy capability and experience for each process, and includes economic assessments for specific parts varying in size and complexity. Overall results show that HIP offers greatest near-term potential for producing the complex parts considered in this study. Author

A86-21729
EFFECT OF MANUFACTURING DEFECTS AND SERVICE-INDUCED DAMAGE ON THE STRENGTH OF AIRCRAFT COMPOSITE STRUCTURES
R. A. GARRETT (McDonnell Aircraft Co., St. Louis, MO) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 325-341. refs

The effects of several types of manufacturing defects and two types of service-induced damage on the static and fatigue strength of aircraft composite structures are examined. The manufacturing defects discussed here include out-of-round holes, delaminations, porosity, improper fastener seating depth, tilted countersinks, interference fit, and multiple installation and removal cycles; the two types of service-induced damage are low energy impact damage and penetration damage. With reference to test results for carbon/epoxy panel structures, it is shown that the above manufacturing defects can be easily detected with correct nondestructive inspection techniques and that the tolerances and controls used in the fabrication and assembly of composite aircraft structures are adequate to assure uniform strength and structural performance. Techniques for reducing the low energy impact and penetration damage are suggested. V.L.

A86-21734
COMPOSITE FABRICS IN A THERMAL PROTECTION APPLICATION
W. P. DOWNEY, JR. (Fairchild Burns Co., Winston-Salem, NC) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 386-399.

Increased airline passenger cabin fire hardness and increased opportunity for passenger survivability in fire scenarios are objectives of a portion of an on-going FAA regulatory program. The overall program is briefly reviewed. Fire blocking of polyurethane seat cushions with sewn slipcover liners of composite fabrics is taking place now. The stated objective of fire blocking is to provide additional cabin egress time in the event of a post crash fire. Previous small scale cabin material flammability tests are reviewed and compared to the new large scale upholstery system test required to demonstrate fire blocking capability. The performance of a fire blocking fabric is not a stand alone parameter but is greatly influenced by the specific polyurethane foam being protected and the decorative upholstery covering installed over the assembly and these factors are reviewed. Additional selection criteria, other than thermal properties, are also reviewed. The range of currently available fabrics is outlined. Many of the fabrics are of fibers such as Kevlar, nomex, glass, PBI, and carbon, most familiar in structural applications. Author

A86-21735
ELECTRODEPOSITED PRIMER SCALE-UP AND QUALIFICATION
G. T. BECKWITH and T. POLLARD (Northrop Corp., Hawthorne, CA) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 400-409. USAF-sponsored research.

Northrop has successfully scaled up an electrodeposited, adhesive bonding primer from a three-gallon research cell to a 250-gallon pilot production tank. This primer is a modified-epoxy, water-based material that was developed jointly by Northrop and Sherwin-Williams for use with 82 C (180 F)-service adhesives. Following the successful scale-up, the primer was fully qualified to the MMM-A-132A, MIL-A-25463B, and Fairchild S-F501 adhesive bonding specifications. In the qualification, specimens were fabricated with Dexter-Hysol EA-9628 adhesive on aluminum adherends that were primed cathodically at low voltage (40 to 45 volts). Two production lots of electrodeposited primer were prepared by Sherwin-Williams and evaluated at Northrop. Control specimens were also prepared with BR-127 and EA-9268 adhesive.

Excellent results were obtained with values that were 40 percent to 160 percent above the specification requirements. Author

A86-21736
IMPROVED TEMPERATURE RESISTANT SEALANTS FOR COMPOSITE & ADHESIVE BONDED FUEL-TANK STRUCTURES
E. M. BROWN, A. F. SHARABY, and T. M. CLARK (Products Research and Chemical Corp., Glendale, CA) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 420-427.

More stringent requirements for aircraft sealants have taxed existing materials both from an increased temperature and overall performance need. More recent manufacturing processes require the use of heat for adhesive bonding, and curing composites. In addition, aircraft performance has increased the requirements for sealant stability at higher operating temperatures. The result has been a new family of aerospace sealants that accommodate these demands. These sealants show a two fold retention of physical properties over existing materials. They are compatible with elevated temperature cure cycles and immediate exposure to heat. They may also be used in elevated temperature applications in faying surfaces. The characteristics of these sealants are presented in this paper. Author

A86-21737
FUEL RESISTANT COATINGS FOR APPLICATIONS IN INTEGRAL TANKS & BLADDER FUEL CELLS
E. M. BROWN and S. RANDAZZO (Products Research and Chemical Corp., Glendale, CA) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 428-432.

With the advent of new materials and processes in the aerospace industry, a number of coating applications for fuel containment have been identified. Several new coatings based on Permapol P-3, a unique fuel resistant polymer, show promise in these aircraft applications. These materials provide a variety of chemical structures, physical characteristics and are summarized in this presentation. Author

A86-21741
ADVANCES IN P/M TITANIUM SHAPE TECHNOLOGY USING THE CERAMIC MOLD PROCESS
V. K. CHANDHOK, J. H. MOLL, C. F. YOLTON, and G. R. MCINDOE (Colt Industries, Crucible Research Center, Pittsburgh, PA) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 495-506. refs

A study was conducted to improve and define the dimensional control of titanium alloy turbine engine rotors produced using prealloyed powder, the ceramic mold process, and hot-isostatic-pressing. Room temperature and elevated temperature properties are presented and compared to conventional forgings and castings. The results show that P/M process is capable of producing rotors with the combined near-net shape capability of castings and the high mechanical property capability of forgings. Author

A86-21742
UNIQUE TOOLING AND MANUFACTURING APPROACH FOR LARGE ADVANCED COMPOSITE AIRCRAFT STRUCTURE
J. S. WINEGAR (Fiber Technology Corp., Provo, UT) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 507-511.

This paper presents a review of innovative tooling and manufacturing concepts which can be adapted for use in a number of large composite structures. Using filament winding as the primary source of fiber deposition, the method has been successfully developed in a variety of large aircraft parts such as a 10' diameter cowling made as a solid wall graphite/epoxy structure with honeycomb hat ring frames. A sandwich-wall graphite/epoxy fuselage for a general business airplane has been demonstrated and is ready for production. Current government and commercially sponsored programs suggest that new and innovative tooling and manufacturing methods must be developed to make such structures a reality. Author

A86-21753
CURRENT AND POTENTIAL USAGE OF TITANIUM CASTINGS FOR AIRFRAME APPLICATIONS
R. R. BOYER (Boeing Commercial Airplane Co., Seattle, WA), W. F. SPURR, and J. M. EDWARDS (TiTech International, Inc., Pomona, CA) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 624-634.

Only recently have titanium castings begun to see widespread acceptance of their use for aircraft and missile applications. Due to its relatively high cost, the selection of titanium in general and titanium castings in specific requires analysis of a number of tradeoffs. Titanium castings are unique in that they can possess properties equivalent to wrought titanium yielding advantages over other alloy systems in strength to weight ratio, corrosion resistance and high temperature performance. Proper design can maximize their cost effectiveness by utilizing net shape capability to minimize both machining and fabrication operations. A number of current titanium casting applications illustrate the various criteria upon which their selection as production method of choice is based. Finally, higher strength titanim beta alloys such as Ti-15-3-3-3 and Ti-38-6-44 demonstrate excellent potential for future applications. Author

A86-21756
PM TECHNIQUES FOR MAKING NEAR-NET-SHAPE TITANIUM ALLOY COMPONENTS
H. GREWE, J. HARTWIG, and J. WILLBRAND (Krupp GmbH, Essen, West Germany) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 662-676.

A86-22020#
FLAME TEMPERATURE ESTIMATION OF CONVENTIONAL AND FUTURE JET FUELS
O. L. GULDER (National Research Council of Canada, Div. of Mechanical Engineering, Ottawa) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 5 p. refs
(ASME PAPER 85-GT-31)

An approximate formula is presented by means of which the adiabatic flame temperature of jet fuel-air systems can be calculated as functions of pressure, temperature, equivalence ratio, and hydrogen to carbon atomic ratio of the fuel. The formula has been developed by fitting of the data from a detailed chemical equilibrium code to a functional expression. Comparisons of the results from the proposed formula with the results obtained from a chemical equilibrium code have shown that the average error in estimated temperatures is around 0.4 percent, the maximum error being less than 0.8 percent. This formula provides a very fast and easy means of predicting flame temperatures as compared to thermodynamic equilibrium calculations, and it is also applicable to diesel fuels, gasolines, pure alkanes, and aromatics as well as jet fuels. Author

A86-22022#
THE QUANTIFICATION AND IMPROVEMENT OF THE THERMAL STABILITY OF AVIATION TURBINE FUEL
J. S. MILLS and D. R. KENDALL (Shell Research, Ltd., Thornton Research Centre, Chester, England) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 6 p. refs
(ASME PAPER 85-GT-33)

The rig performance of aircraft fuels are evaluated. The test rig and experimental procedures for testing eleven fuels in a heat exchanger are described. Fuel performance limits between 125-210 C are obtained; it is observed that an increase in operating temperature results in an increase in operational difficulties for certain fuels. The influence of oxidation of fuel on the fuel's performance is examined. It is concluded that the performance of fuels depends on the initiation of radical oxidation reactions and sulfur content. The effect of metals on the oxidation process and fuel is investigated. The metals catalyze the oxidation reactions resulting in low fuel stability. The doping of fuels with metal deactivating additives to reduce the catalytic effect of metals is studied. The additive is effective in reducing the catalyzation; however, the chelates formed contain some residual catalytic activity. I.F.

A86-22062#
STRAIN ISOLATED CERAMIC COATINGS FOR GAS TURBINE ENGINES
R. P. TOLOKAN, J. B. BRADY, and G. P. JARRABET (Brunswick Corp., Technetics Div., DeLand, FL) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 6 p. refs
(ASME PAPER 85-GT-96)

Plasma sprayed ceramic coatings are used in gas turbine engines to improve component temperature capability and cooling air efficiency. Strain isolated ceramic coatings offer improved coating life and increased insulating capability. A low modulus fiber metal strain isolator between ceramic and metal backing acts to reduce the stress on the ceramic during thermal cycling. Strain isolated coatings can tolerate greater ceramic thickness and broader operating conditions than nonstrain isolated coatings when subjected to thermal shock. Ceramic coatings are durable only within a narrow range of operating conditions. Coating designs should be based on real operating conditions for success. Thermal shock testing is useful for evaluating ceramic coatings if test and sample design are representative of the intended application.
Author

A86-22706*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
RESEARCH ON ANTIMISTING FUEL FOR SUPPRESSION OF POSTCRASH AIRCRAFT FIRES
V. SAROHIA, P. PARIKH, A. YAVROUIAN, and E. MATTHYS (California Institute of Technology, Jet Propulsion Laboratory, Pasadena) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 20 p. refs
(Contract NAS7-918; NASA ORDER RE-152-293; DOT-FA03-80-A-00215)
(AIAA PAPER 86-0573)

Recent experimental results in the field of post-crash aircraft fire suppression are reviewed, with emphasis given to antimisting kerosene fuel (AMK). Findings in three major areas of study are presented, including: rheological studies (skin friction, and heat transfer); fuel breakup processes and nozzle spray combustion; and the development of inline blenders for production of AMK at the refueling point. An interpretation of the results of the FAA/NASA Controlled Impact Demonstration of AMK fuel is also presented. It is concluded that AMK is a sound concept and offers several advantages over conventional fuels in any crash scenario involving post-crash fires. I.H.

N86-16273# Rolls-Royce Ltd., Derby (England). Non-Metallics Labs.
THE MATERIAL DEVELOPMENT, COMPONENT MANUFACTURE, AND POST-SERVICE EVALUATION OF RB211-524 COWL DOORS UTILIZING CARBON FIBRE COMPOSITE MATERIALS
G. A. OWENS 23 Jul. 1985 24 p refs
(PNR-90275) Avail: NTIS HC A02/MF A01

A lightweight engine element including carbon fiber reinforced epoxy composite skin bonded to aluminum alloy honeycombs is described. Material selection, mechanical property data and evaluation of the material's environmental resistance are discussed. Corrosion resistance of the honeycomb construction is considered. The effect of the operating conditions is assessed in 6000 hr tests. No significant structural deterioration is exhibited.
Author (ESA)

N86-16276# Societe Nationale Industrielle Aerospatiale, Saint-Medard-en-Jalles (France).
NONDESTRUCTIVE INSPECTION: AN EFFICIENT INVESTMENT [LE CONTROLE NON DESTRUCTIF: UN INVESTISSEMENT RENTABLE]
F. ALBUGUES 1985 13 p In FRENCH Presented at 4th Journees des Materiaux Composites, Bordeaux, France, 14-15 May 1985
(SNIAS-852-430-110) Avail: NTIS HC A02/MF A01

Nondestructive methods and their application to composite materials inspection in the aircraft industry are reviewed. The methods include visual control, dimension control, radiography, thermography, ultrasonics, acoustic analysis, holographic interferometry, optical microscopy, optoelectronics, and microanalysis. Author (ESA)

N86-16277# Societe Nationale Industrielle Aerospatiale, Paris (France).
ARENYL: A SOLUBLE MOLD TECHNOLOGY [ARENYL: UNE TECHNOLOGIE DE MANDRIN SOLUBLE]
F. GOFFENEY 1985 5 p In FRENCH Presented at 4th Journees des Materiaux Composites, Bordeaux, France, 14-15 May 1985
(SNIAS-852-430-111) Avail: NTIS HC A02/MF A01

Application of Arenyl to composite materials molding for the aircraft industry is described. Arenyl is composed of polyvinyl alcohol (PVA) and sand, has good mechanical properties and may be disaggregated by water solution of the PVA. It is concluded that Arenyl offers a good solution to molding problems. Aircraft element examples are given. Author (ESA)

N86-16279# Societe Nationale Industrielle Aerospatiale, Suresnes (France).
THE APPLICATIONS OF COMPOSITE MATERIALS IN THE AERONAUTICAL DOMAIN [LES APPLICATIONS DES COMPOSITES DANS LE DOMAINE AERONAUTIQUE]
G. HELLARD, G. HILAIRE, and M. TORRES Apr. 1985 34 p In FRENCH
(SNIAS-852-551-103) Avail: NTIS HC A03/MF A01

The physical properties and the applications of composite materials to aircraft construction are described. Kevlar, carbon, and glass fiber properties are compared. Weight reduction and cost reduction are examined. Composite elements used in aircraft are described. Author (ESA)

N86-16315# Imperial Coll. of Science and Technology, London (England). Computational Fluid Dynamics Unit.
THE TWO-FLUID MODEL OF TURBULENT COMBUSTION APPLIED TO AN IDEALISED ONE-DIMENSIONAL, UNSTEADY, CONFINED, PRE-MIXED FLAME
J. Z. Y. WU Aug. 1984 59 p refs
(PDR/CFDU/IC/21) Avail: NTIS HC A04/MF A01

The two-fluid model of turbulent combustion was applied to a one-dimensional, unsteady, confined, premixed flame with idealized initial and boundary conditions. The results show that steady oscillations may occur after the steady-state flame is disturbed. A

systematic, parametric study is performed to establish instability regions. The results indicate a possible mechanism of oscillatory burning in, for example, afterburner systems for aircraft jet engines. Author (ESA)

N86-16374# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
AGARD CORROSION HANDBOOK. VOLUME 1: CORROSION, CAUSES AND CASE HISTORIES
W. WALLACE (National Research Council, Ottawa, Canada), D. W. HOEPPNER (Toronto Univ.), and P. V. KANDACHAR (Fokker, Schiphol, Netherlands) Jul. 1985 205 p refs
(AGARD-AG-278-VOL-1; ISBN-92-835-1505-6) Avail: NTIS HC A10/MF A01

A need exists to keep aircraft operators and maintenance personnel aware of the science and technology of corrosion as it applies to aircraft structures. Information is provided on the aircraft operating environment, corrosion theory, common airframe materials and their response to corrosion, the detection of corrosion, and methods employed to control corrosion in aircraft structures and materials. Also given are case histories of the deterioration or failure of components in typical aircraft and the means of detection are detailed and the remedical action taken. Microbiological corrosion is also discussed. The handbook is intended to assist in the early diagnosis of developing corrosion problems and in the selection of appropriate corrective measures. Author

N86-17485# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France). Lab. Techniques Nouvelles.
EVALUATION OF THE CIBA-GEIGY R6376 IM6 PREPREG [EVALUATION DU PREIMPREGNE CIBA GEIGY R6376-IM6]
J. LEVESQUE and F. HENRIOT 21 Jan. 1985 74 p In FRENCH
(Contract STPA-83-96-028)
(DGT-26.649) Avail: NTIS HC A04/MF A01

The R6376-IM6 prepreg tensile and impact properties were compared with other commercially available products used in aircraft manufacturing. The comparisons do not show improvements over the currently used preimpregnated composites. Author (ESA)

N86-17486# Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France). Lab. Techniques Nouvelles.
STUDY OF COMPOSITE MATERIAL CURING MOLDS [ETUDE D'UN SOMMIER DE CUISSON EN MATERIAUX COMPOSITES]
S. DELLUS 8 Feb. 1985 22 p In FRENCH
(Contract STPA-83-96-028)
(DGT-26.817) Avail: NTIS HC A02/MF A01

A composite mold to manufacture carbon reinforced expoxy matrix composite elements for the aircraft industry is studied. The working temperature for curing is 175C. The tests were carried out either using preimpregnated composites or manually impregnated composites. The study shows that the molds do not differ significantly from the models, that the deformation is low after several autoclave cycles, and that there are consistent advantages regarding weight and thermal inertia. Author (ESA)

N86-17493# Societe Nationale Industrielle Aerospatiale, Saint-Medard-en-Jalles (France).
COMPOSITE MATERIALS: A SOURCE OF INNOVATION [LES MATERIAUX COMPOSITES: SOURCE D'INNOVATION]
A. PHAN 1985 7 p In FRENCH; ENGLISH summary Submitted for publication
(SNIAS-852-430-113) Avail: NTIS HC A02/MF A01

A composite materials design methodology based on the concept of user needs technical specifications is proposed. This results from an equilibrium between user requirements and the technological limitations for manufacturing a specified product. The advantages of such a specification are commented on. Author (ESA)

N86-17498# Societe Nationale Industrielle Aerospatiale, Saint-Medard-en-Jalles (France).
DESIGN OF NONAXYSYMMETRIC STRUCTURES (TURBOJET ENGINE NACELLE ELEMENT) Thesis [CONCEPTION DE STRUCTURES NON AXISYMETRIQUES (ELEMENTS DE NACELLE DE REACTEUR)]
J. LAMALLE 1985 59 p refs In FRENCH
(SNIAS-852-430-119) Avail: NTIS HC A04/MF A01

The design of an air inlet covering with an average diameter of 2200 mm and length varying between 330 and 510 mm is discussed. The purpose it to show how an asymmetric element can be manufactured by filament winding, using composite materials. The choice of winding procedure is analyzed and all the manufacturing steps are described. The analytical verification of the behavior under external pressure gives results within the specifications. Author (ESA)

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A86-19375* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
LUBRICATION AND PERFORMANCE OF HIGH-SPEED ROLLING-ELEMENT BEARINGS
E. V. ZARETSKY, F. T. SCHULLER, and H. H. COE (NASA, Lewis Research Center, Cleveland, OH) Lubrication Engineering (ISSN 0024-7154), vol. 41, Oct. 1985, p. 725-732. Previously announced in STAR as N85-21658. refs

Trends in aircraft engine operating speeds have dictated the need for rolling-element bearings capable of speeds to 3 million DN. A review of high-speed rolling-element bearing state-of-the-art performance and lubrication is presented. Through the use of under-race lubrication and bearing thermal management bearing operation can be obtained to speeds of 3 million DN. Jet lubricated ball bearings are limited to 2.5 million DN for large bore sizes and to 3 million DN for small bore sizes. Current computer programs are able to predict bearing thermal performance. Author

A86-19970*# Johns Hopkins Univ., Laurel, Md.
EVOLUTION AND STATUS OF CFD TECHNIQUES FOR SCRAMJET APPLICATIONS
M. E. WHITE (Johns Hopkins University, Laurel, MD), J. P. DRUMMOND, and A. KUMAR (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 21 p. refs
(AIAA PAPER 86-0160)

Computational Fluid Dynamics (CFD) methods are presently applied to the design and analysis of scramjet propulsion systems for missiles and aircraft operating at speeds in excess of Mach 5, in forms ranging from simple inviscid codes for parametric studies of inlet geometries to Navier-Stokes codes incorporating chemistry models which address complex scramjet combustion phenomena. Attention is given to the development history of CFD for the hypersonic regime, as well as to scramjet flowfield modeling in inlets, combustors and nozzles, and prospective development trends. O.C.

A86-20173#
FATIGUE LIFE PREDICTION UNDER COMPLEX LOAD USING LOCAL STRAIN APPROACH AND RELATIVE MINER'S RULE
A. LUO (Aviation Industry Department, People's Republic of China) and F. WU (Northwest Polytechnic University, Xian, People's Republic of China) Acta Mechanica Solida Sinica, Sept. 1985, p. 327-337. In Chinese, with abstract in English. refs

Crack formation life predictions for two kinds of central notched specimens using local strain approach and relative Miner's (1945) rule (i.e., relative linear cumulative damage rule) are described and discussed in this paper. Crack formation lives of these two kinds of specimens under Fighter Aircraft Loading Standard for Fatigue Evaluation load spectra are obtained. The calculation results were compared with the fatigue testing results, and it was found that the method using a finite element analysis to predict crack formation lives is better than the modified Neuber's (1961) rule. In addition, the accuracy of predicting fatigue lives is considerably improved when a local strain approach combined with the relative Miner's rule is used, instead of the commonly used Miner's rule. Author

A86-20175#
MEASUREMENT OF ELASTIC-PLASTIC STRAIN FIELD AT THE CURVE SURFACE CRACK TIP
P. FENG and H. WANG (Institute for Aircraft Structural Strength, People's Republic of China) Acta Mechanica Solida Sinica, Sept. 1985, p. 346-352. In Chinese, with abstract in English. refs

In this paper a new technique of specimen grating copy is described. Combining the technique of spatial filtering, fringe multiplication and image processing, it can be used to measure the elastic-plastic strain field at the curve surface crack tip of axles. pivoting wings, pillar sheets and cone shells. This new technique can even be used to measure the surface strain field of rotary axles, rotary flywheels and rotary wings. Author

A86-20516#
SYNCHRONIZING CHARACTERISTICS OF A LARGE VARIABLE FREQUENCY STARTING SYSTEM
J. K. BRANDON (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN) IN: SOUTHEASTCON '84; Proceedings of the Conference, Louisville, KY, April 8-11, 1984 . New York, Institute of Electrical and Electronics Engineers, 1984, p. 339-342.

The Aeropropulsion Systems Test Facility (ASTF) is a new jet engine test facility presently under construction by the U.S. Air Force near Tullahoma, Tennessee. The design utilizes a relatively unique variable frequency starting system (VFSS) for startup of the various large electrical drive systems associated with ASTF. During the design phase, one of the major obstacles was to identify the most advantageous method for automatically transferring the large synchronous motors from the VFSS to the main power system. This paper describes the synchronizing techniques and equipment chosen for the ASTF variable frequency starting system. Author

A86-20638* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
REPEATABILITY OF MIXED-MODE ADHESIVE DEBONDING
R. A. EVERETT, JR. (NASA, Langley Research Center; U.S. Army, Structures Laboratory, Hampton, VA) and W. S. JOHNSON (NASA, Langley Research Center, Hampton, VA) IN: Delamination and debonding of materials . Philadelphia, PA, American Society for Testing and Materials, 1985, p. 267-281. Previously announced in STAR as N84-19565. refs

The repeatability of debond growth rates in adhesively bonded subjected to constant-amplitude cyclic loading was studied. Debond growth rates were compared from two sets of cracked-lap-shear specimens that were fabricated by two different manufacturers and tested in different laboratories. The fabrication method and testing procedures were identical or both sets of specimens. The specimens consisted of aluminum adherends bonded with FM-73 adhesive. Critical values of strain-energy-release rate were also determined from specimens that were monotonically loaded to failure. The test results showed that the debond growth rates for the two sets of specimens were within a scatter band which is similar to that observed in fatigue crack growth in metals. Cyclic debonding occurred at strain-energy-release rates that were more than an order of magnitude less than the critical strain-energy-release rate in static tests. Author

A86-20649
THERMOGRAPHIC INSPECTION OF CARBON EPOXY STRUCTURES
D. J. HILLMAN and R. L. HILLMAN (McDonnell Aircraft Co., St. Louis, MO) IN: Delamination and debonding of materials . Philadelphia, PA, American Society for Testing and Materials, 1985, p. 481-493.

In-service damage to composite fighter aircraft structures is normally readily observed visually; often very serious damage can be identified as such by the visual observer. However, it is impossible to see whether or not nondestructive inspection (NDI) is warranted at sites consisting solely of surface scratches and dents because of the possibility of impact damage and other damages which appear superficial but may be significant. The tendency, therefore, has been to quantitatively inspect every dent and scratch observed on composite structures during field NDI to avoid overlooking a serious damage site. The purpose of the efforts reported in this paper is to eliminate this practice by providing a fast, inexpensive, large-area NDI tool capable of screening out superficial damage from serious damage. Author

A86-20792
A NEW METHOD OF ANALYZING WAVE PROPAGATION IN PERIODIC STRUCTURES - APPLICATIONS TO PERIODIC TIMOSHENKO BEAMS AND STIFFENED PLATES
D. J. MEAD (Southampton, University, England). Journal of Sound and Vibration (ISSN 0022-460X), vol. 104, Jan. 8, 1986, p. 9-27. refs

A response function is found for an infinite, uniform, one-dimensional structure which is subjected to an array of harmonic forces or moments, spaced equidistantly, and which have a constant phase or ratio between any adjacent pair. Receptance functions are derived for these 'phased arrays'. They are used to set up a general determinantal equation for the propagation constants of the infinite structure when it is made periodic by the addition of an infinite set of regular constraints. They are also used to set up equations for the response of the structure to a convected harmonic pressure field. The method enables the equations for the propagation constants and for the response to convected loading to be set up with much greater facility than by earlier methods. It only requires a knowledge of the response function of the infinite uninterrupted structure under a single-point harmonic force or moment. The general equation for the propagation constants is used to study (1) a simply supported periodic Timoshenko beam, and (2) a parallel plate with periodic beam-type stiffeners. Some calculated propagation constants are presented and discussed. The periodic plate results are relevant to integrally stiffened skins of the type used in aeroplanes. Author

A86-20921
A SHARED SATELLITE SYSTEM WOULD SATISFY MANY FUTURE AVIATION NEEDS
J. D. KIESLING and R. E. ANDERSON ICAO Bulletin, vol. 40, Nov. 1985, p. 15-20.

The development of a continental mobile satellite system for aircraft communication is proposed. The system is to provide communication and surveillance for air traffic control and aeronautical operational control. The two-satellite ranging and position fixing of the satellite system are analyzed. The system architecture requires consideration of satellite earth coverage, a frequency and polarization plan, satellite and mobile power and power density, and modulation standards. The use of spot beams and frequency reuse is examined, and diagrams of coverage areas and frequency reuse are presented. Examples of aviation system and mobile satellite system frequency plans are provided.

Differences in satellite characteristics, such as antenna gain, transmitter powers and receiver sensitivities, and mobile antenna gains and powers are discussed. The components and requirements for a typical satellite transponder concept, in particular an aircraft-mounted antenna, are described. I.F.

A86-21026
COMPUTATIONAL METHODS IN VISCOUS FLOWS
W. G. HABASHI, ED. (Concordia University, Montreal, Canada) Swansea, Wales, Pineridge Press (Recent Advances in Numerical Methods in Fluids. Volume 3), 1984, 678 p. For individual items see A86-21027 to A86-21044.

The papers presented in this volume focus on new finite difference and finite element approaches for both incompressible and compressible Navier-Stokes equations, with attention also given to viscous-inviscid interaction problems. Particular topics discussed include some aspects of finite element approximations of incompressible viscous flows, numerical solution of the compressible viscous flow field about a complete aircraft in flight, and finite difference simulation of unsteady interactive flows. Papers are also presented on calculation of separated flows by viscous-inviscid interaction, turbulent flow and heat transfer in coupled solid/fluid systems, and the effect of the solid particle size in two-phase flow around a plane cylinder. V.L.

A86-21246#
A SYNTHETIC APERTURE RADAR (SAR) FOR COMMERCIAL APPLICATIONS
B. L. BULLOCK (Intera Technologies, Ltd., Calgary, Canada) and A. KOZMA (Michigan, Environmental Research Institute, Ann Arbor) IN: International Symposium on Remote Sensing of Environment, 18th, Paris, France, October 1-5, 1984, Proceedings. Volume 3 . Ann Arbor, MI, Environmental Research Institute of Michigan, 1985, p. 1733-1742. refs

Studies leading to the design specifications and subsequent development of a SAR built solely for commercial applications are described. Background searches were made of potential users and their requirements and the corresponding technology. The system developed is called STAR 1 (for Sea-Ice and Terrain Assessment Radar); it is an X-band system installed in a light turboprop aircraft. The data are digitally processed in real time aboard the aircraft and the image is telemetered to a ground station for immediate use. The system is currently operational and has performed a number of tasks including support of arctic drilling and engineering, iceberg detection, arctic transportation, and terrain surveys. D.H.

A86-21513
COMPARISON OF CALCULATED AND MEASURED HEIGHT PROFILES OF TRANSVERSE ELECTRIC VLF SIGNALS ACROSS THE DAYTIME EARTH-IONOSPHERE WAVEGUIDE
E. C. FIELD, JR., C. R. WARBER (Pacific-Sierra Research Corp., Los Angeles, CA), P. A. KOSSEY, E. A. LEWIS, and R. P. HARRISON (USAF, Rome Air Development Center, Bedford, MA) Radio Science (ISSN 0048-6604), vol. 21, Jan.-Feb. 1986, p. 141-149. refs

Airborne VLF antennas radiate energy that propagates via both transverse electric (TE) and transverse magnetic (TM) modes in the earth-ionosphere waveguide. In order to compare the structure of such signals, measurements were made using rocket probes launched from Wallops Island, Virginia. The probes measured TE and TM fields at all altitudes between the ground and the base of the ionosphere. The nearly horizontal airborne transmitting antenna radiated a TE signal that was stronger than its TM signal at altitudes above about 10 km. The signals comprised one or more well-defined TE or TM waveguide modes. Calculated height profiles agree well with the measured ones and correctly reproduce details of profile structure caused by interaction between two or more modes. Author

A86-21709
SPF ALUMINUM - A FIRST FOR THE S-76B HELICOPTER
R. FIORE and M. SCHWARTZ (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 88-96.

Superplastic forming (SPF) of aluminum, basically a low strain rate hot forming process employing specially processed sheet material, permits the forming of complex shapes in one operation usually with considerable cost savings over conventional manufacturing methods. The ability to form complex, one-piece parts is due to the inherent characteristics of the process and the fine grained material which is used. Whereas most metals fracture at strains far below 100 percent, in SPF, elongations of 500-1200 percent are easily obtainable. SPF now provides the manufacturing capability for making complex parts, normally requiring composite lay-ups or welded assemblies, at greatly reduced cost. Sikorsky Aircraft has used this technology, and has received FAA approval to replace two Kevlar and fiberglass parts on the S-76B commercial helicopter at substantial cost savings without a weight penalty or the necessity for a design change. This is the first SPF aluminum production application on an American made helicopter. Author

A86-21714
REQUIREMENTS FOR TAILORING OF MATERIAL PROPERTIES OF VISCOELASTICALLY DAMPED BONDED LAMINATES IN AIRCRAFT STRUCTURES
K. B. SANGHA and S. N. VACCA (LTV Aerospace and Defense Co., Vought Aero Products Div., Dallas, TX) IN: National SAMPE Technical Conference, 17th, Kiamesha Lake, NY, October 22-24, 1985, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1985, p. 135-146. refs

Adhesively bonded laminates have been used for several years in the aerospace industry. Over two decades ago, their potential as noise and vibration damping mechanisms was recognized. With major new advances in materials and processes technology of adhesives, one is confronted with a plethora of adhesives that can be used for an application. This paper outlines some requirements of adhesive properties to be effective damping materials. Parameter variations are used to emphasize the importance of optimal selection of the dynamic properties of an adhesive for each application. The influence of frequency, temperature and strain amplitude is recapitulated, and their relative influences are delineated. The influence of altering the quantity of some constituents of an adhesive on damping effectiveness is presented through test data. Author

A86-21826
SYMPOSIUM GYRO TECHNOLOGY 1984; PROCEEDINGS OF THE SYMPOSIUM, UNIVERSITAET STUTTGART, WEST GERMANY, SEPTEMBER 11, 12, 1984
H. SORG, ED. (Stuttgart, Universitaet, West Germany) Stuttgart/Duesseldorf, Universitaet Stuttgart/Deutsche Gesellschaft fuer Ortung und Navigation, 1984, 455 p. For individual items see A86-21827 to A86-21843.

Among the topics discussed are: drift and scale factor tests on the SEL fiber gyro; integrated optical rate sensor development; and the beam geometry of a ring laser gyro in relation to its performance. Consideration is also given to: a fast filtering technique for measuring random walk in a laser gyro; vibratory gyroscopic sensors; a redundant strapdown reference for advanced aircraft flight control systems; and a low-cost piezoelectric rate/acceleration sensor. Additional topics include: an inertial guidance system for a Low-Earth-Orbit (LEO) vehicle; and signal disturbance effects in a strapdown northfinder. I.H.

A86-21891
AIRBORNE COMMUNICATIONS RECONSTITUTION EXPERIMENTS
G. A. DESBRISAY, B. C. FAIR, and M. S. FRANKEL (SRI International, Advanced Information-Technology Applications Center, Menlo Park, CA) IN: EASCON '84; Proceedings of the Seventeenth Annual Electronics and Aerospace Conference, Washington, DC, September 10-12, 1984 . New York, Institute of Electrical and Electronics Engineers, 1984, p. 311-319. refs

As a result of the development of advanced modern weapon systems and the high mobility of forces during battle, military forces will face a highly dynamic environment in future confrontations. The present paper is concerned with investigations regarding a survivable, Strategic Air Command (SAC) Command and Control environment. The environment considered depends upon a highly survivable communication system and upon redundantly distributed, automatically updated databases. In mid-1980, the Strategic Command, Control, and Communications (CCC) Testbed was created. The network technologies which are being developed in the CCC Testbed are rapidly approaching the point where they can provide the required capabilities. G.R.

A86-21895#
CAD/CAM DESIGNER - JACK OF ALL TRADES
C. F. HERNDON and R. L. GALLO (General Dynamics Corp., Fort Worth, TX) Aerospace America (ISSN 0740-722X), vol. 24, Jan. 1986, p. 52-54, 56.

Aerospace design engineers are increasingly required to have more extensive knowledge of CAD/CAM tooling and manufacturing methods, in order to ensure that datasets can yield error-free components and assemblies. For structural concept design, engineers will work at the same CAD/CAM workstation on which the final component will be defined, controlling methods that yield the optimum solution for each member of a structural system from the viewpoints of both weight (for given strength) and producibility. O.C.

A86-21996* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
MEASUREMENTS OF ROTATING BUBBLE SHAPES IN LOW-GRAVITY ENVIRONMENT
F. LESLIE (NASA, Marshall Space Flight Center, Huntsville, AL) Journal of Fluid Mechanics (ISSN 0022-1120), vol: 161, Dec. 1985, p. 269-279. NASA-supported research. refs

Measurements of rotating equilibrium bubble shapes in the low-gravity environment of a free-falling aircraft are presented. Emphasis is placed on bubbles which intersect the container boundaries. These data are compared with theoretical profiles derived from Laplace's formula and are in good agreement with the measurements. The interface shape depends on the contact angle, the radius of intersection with the container, and the parameter F, which is a measure of the relative importance of centrifugal force to surface tension. For isolated bubbles F has a maximum value of 1/2. A further increase in F causes the bubble to break contact with the axis of rotation. For large values of F the bubble becomes more cylindrical and the capillary rise occurs over a thinner layer in order that the small radius of curvature can generate a sufficient pressure drop to account for the increased hydrostatic contribution. Author

A86-22035#
FULL COVERAGE DISCRETE HOLE FILM COOLING - THE INFLUENCE OF HOLE SIZE
G. E. ANDREWS, A. A. ASERE, M. L. GUPTA, and M. C. MKPADI (Leeds, University, England) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 8 p. refs
(Contract SERC-GR/B/00336; SERC-GR/B/67827)
(ASME PAPER 85-GT-47)

The influence of hole size and hence blowing rate on full coverage discrete hole wall cooling for gas turbine combustion chamber applications was investigated. Two temperature conditions were used first, a 750 K gas temperature and 300 K coolant, and secondly a realistic combustor primary zone conditions of 2100 K flame temperature and 700 K coolant. It was shown that a large hole size resulted in a significant improvement in the overall cooling effectiveness due to a reduced film heat transfer coefficient. At high temperature the cooling effectiveness was reduced due to radiative heat transfer from the flame gases. At low coolant flow large temperature increases of the coolant occurred within the wall and approached the transpiration situation. Author

A86-22054*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A REVIEW AND ANALYSIS OF BOUNDARY LAYER TRANSITION DATA FOR TURBINE APPLICATION
R. E. GAUGLER (NASA, Lewis Research Center, Cleveland, OH) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 8 p. Previously announced in STAR as N85-10306. refs
(ASME PAPER 85-GT-83)

A symposium on transition in turbines was held at the NASA Lewis Research Center. One recommendation of the working groups was the collection of existing transition data to provide standard cases against which models could be tested. A number of data sets from the open literature that include heat transfer data in apparently transitional boundary layers, with particular application to the turbine environment, were reviewed and analyzed to extract transition information from the heat transfer data. The data sets reviewed cover a wide range of flow conditions, from low speed, flat plate tests to full scale turbine airfoils operating at simulated turbine engine conditions. The results indicate that free stream turbulence and pressure gradient have strong, and opposite, effects on the location of the start of transition and on the length of the transition zone. R.S.F.

A86-22056#
INTERDEPENDENCE OF CENTRIFUGAL COMPRESSOR BLADE GEOMETRY AND RELATIVE FLOW FIELD
H. KRAIN (DFVLR, Institut fuer Antriebstechnik, Cologne, West Germany) ASME, International Gas Turbine Conferences and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 7 p. refs
(ASME PAPER 85-GT-85)

The influence of the impeller blade geometry on the calculated relative flow field has been studied by means of an impeller design program available at DFVLR (Krain, 1984). Several geometrical parameters were varied, however, the meridional channel geometry was always kept constant. By this approach the blade wrap angle has been found to react significantly on the relative flow which is illustrated by comparing two designs with different wrap angles. Primarily in the hub/leading edge area a better boundary layer flow connected with a reduction of blade loading was obtained by increasing the wrap angle. But also in the shroud/pressure side area the increased blade looping attributed to an additional flow stabilization. Author

A86-22070#
HEAT TRANSFER MEASUREMENTS WITH FILM COOLING ON A TURBINE BLADE PROFILE IN CASCADE
F. G. HORTON, D. L. SCHULTZ (Oxford University, England), and A. E. FOREST (Rolls-Royce, Ltd., Derby, England) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 10 p. Research supported by the Ministry of Defence (Procurement Executive) and Rolls-Royce, Ltd. refs
(ASME PAPER 85-GT-117)

Heat transfer measurements with film cooling have been made on a gas turbine rotor profile in a cascade at engine representative operating conditions. The blade temperature was varied independently to investigate the scaling of heat transfer coefficient, and a superposition model was found to correlate the data. Contrasting results are presented for films on the two surfaces, along with predictions from a two-dimensional boundary layer method. Author

A86-22071#
INVERSE DESIGN OF COOLANT FLOW PASSAGE SHAPES WITH PARTIALLY FIXED INTERNAL GEOMETRIES
S. R. KENNON and G. S. DULIKRAVICH (Texas, University, Austin) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 10 p. refs
(ASME PAPER 85-GT-118)

A method has been developed for the design and analysis of complex coolant flow passage shapes in internally cooled turbine engines. The method is particularly applicable to turbine airfoil cascade inverse design but may also be applied to the design of other nonadiabatic boundaries such as missile cone tips and internal combustion engine cylinder. The method makes it possible to specify and fix the temperature or the heat flux at the turbine airfoil outer surface, together with the desired temperature at the coolant/blade interfaces. Coupled with an appropriate flow solver and stress analysis code, the method provides accurate estimates of the blade surface temperature and heat flux distribution in the coolant passage. A first order panel method is used to solve the Laplace equations for steady heat conduction within the solid portions of the hollow blade. In order to illustrate the efficiency of the method, numerical results are presented for the case of a turbine airfoil having three coolant holes. The discretized temperature contours for the inner and outer parts of the blade are illustrated in graphic form. I.H.

A86-22073#
DEVELOPMENT OF A DESIGN MODEL FOR AIRFOIL LEADING EDGE FILM COOLING
A. R. WADIA and D. A. NEALY (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 12 p. refs
(ASME PAPER 85-GT-120)

A series of experiments on scaled cylinder models having injection through holes inclined at 20, 30, 45, and 90 degrees are presented. The experiments were conducted in a wind tunnel on several stainless steel test specimens in which flow and heat transfer parameters were measured over simulated airfoil leading edge surfaces. On the basis of the experimental results, an engineering design model is proposed that treats the gas-to-surface heat transfer coefficient with film cooling in a manner suggested by Luckey and L'Ecuyer (1981). It is shown that the main factor influencing the averaged film cooling effectiveness in the showerhead region is the inclination of the injection holes. The effectiveness parameter was not affected by variations in the coolant-to-gas stream pressure ratio, the freestream Mach number, the gas to coolant temperature ratio, or the gas stream Reynolds number. Experience in the wind tunnel tests is reflected in the design of the model in which the coolant side heat transfer coefficient is offset by a simultaneous increase in the gas side film coefficient. The design applications of the analytical model are discussed, with emphasis given to high temperature first stage turbine vanes and rotor blades. I.H.

A86-22084*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NASA LEWIS RESEARCH CENTER/UNIVERSITY GRADUATE RESEARCH PROGRAM ON ENGINE STRUCTURES
C. C. CHAMIS (NASA, Lewis Research Center, Cleveland, OH) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 10 p. Previously announced in STAR as N85-18375.
(ASME PAPER 85-GT-159)

NASA Lewis Research Center established a graduate research program in support of the Engine Structures Research activities. This graduate research program focuses mainly on structural and dynamics analyses, computational mechanics, mechanics of composites and structural optimization. The broad objectives of the program, the specific program, the participating universities and the program status are briefly described. Author

A86-22099#
INVESTIGATION OF JET-FILMING AIRBLAST ATOMIZER
Q.-S. ZHAO and Y.-F. YU (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 7 p. refs
(ASME PAPER 85-GT-185)

The jet-filming airblast atomizer is another kind of airblast atomizer differing from a prefilming airblast atomizer. Its atomizing mechanism and performance were investigated experimentally and theoretically. The effects of design parameters on the mean droplet size SMD and the thickness of the liquid film were obtained. The inherent mechanism consisting of three atomizing processes was proved. From this, the performance curves of atomization and thickness of liquid film can be explained and the principles of design of this kind of atomizer were derived. The results obtained show that the performance of the jet-filming airblast atomizer is better than that of the prefilming type, and it is simple in design. So it is advantageous to apply this kind of atomizer to an advanced aircraft engine. Author

A86-22134#
STRUCTURAL AND MATERIAL CONSIDERATIONS FOR ADVANCED FIGHTERS
T. R. ROONEY (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 8-1 to 8-6.

Current and emerging structural technologies provide the opportunity to make a quantum jump in the design of next generation aircraft. The impact of new materials and structural concepts on the performance, producibility and life cycle costs of advanced fighters is discussed. The expected applications of advanced materials tehnologies in metallics, composites and hybrid structures are described. Author

A86-22142#
SUPERPLASTICALLY-FORMED/DIFFUSION-BONDED M TECHNOLOGY TRANSITION CASE STUDY
E. D. BOUCHARD and J. P. SORENSEN (McDonnell Aircraft Co., St. Louis, MO) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 19-1 to 19-4.

The principles of the superplastic forming/diffusion bonding (SPF/DB) of titanium and of the low-cost structural concepts employed in the new F-15E aft fuselage are described. Application of the SPF/DB of Ti technology in the F-15E aft fuselage provides a good case study in the transition of the SPF/DB Ti research and development program from laboratory scale to production state. It is shown that use of the new technology will result in a significant reduction of acquisition cost, life-cycle costs, reduction in structural weight, and improved durability and will open the door for further application on new aircraft, such as the Advanced Tactical Fighter. I.S.

A86-22143#
TRANSITION OF ADVANCED MATERIALS AND STRUCTURES - SINGLE CRYSTAL BLADES
M. M. ALLEN and D. S. HALFPAP (United Technologies Corp., Pratt and Whitney, West Palm Beach, FL) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 20-1 to 20-4.

The paper discusses the generic path of manufacturing technology R&D implementation using single crystal turbine blades as an example. Single crystal turbine airfoils represent an evolutionary outgrowth of P&W developed directional solidification process which significantly contributed to gas turbine fuel efficiency and performance. The following key elements of implementation are dsicussed: Technology payoff, laboratory specimen and rig testing; engine testing and transition to production. Author

A86-22144#
COMPOSITES TECHNOLOGY TRANSFER AND TRANSITION
D. REED (General Dynamics Corp., Fort Worth, TX) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 21-1 to 21-4.

This paper gives a brief overview of General Dynamics' involvement in composites manufacturing since 1964; the development of tape-laying machine technology; and the transfer and transition of that technology throughout industry. Special emphasis is given to the importance to the aircraft industry of Technology Modernization and Manufacturing Technology programs in providing incentives for composites technology development. Author

A86-22178
IMPLICATIONS OF NEW AIRCRAFT AVIONICS RELIABILITY PERFORMANCE
M. E. MOORHEAD (Rockwell International Corp., Collins Div., Melbourne, FL) IN: Environmental integration technology today for a quality tomorrow; Proceedings of the Thirtieth Annual Technical Meeting, Orlando, FL, May 1-3, 1984 . Mount Prospect, IL, Institute of Environmental Sciences, 1984, p. 232-235.

An evaluation is made of MTBF values projected for avionics operating under environmental conditions typical of state-of-the-art 'digital' aircraft. Equipment reliability levels obtained during the fist year of operational experience with the B 767 and B 757 airliners are presented and compared with levels characteristic of previous avionic failure rates. Theoretical reliability levels based on existing MIL-HDBK-217 failure rate curves and acceleration factors are related to demonstrated performance levels, in order to identify points of correlation as well as discrepancies. O.C.

A86-22192
THE AIR FORCE APPROACH TO ENVIRONMENTAL STRESS SCREENING
E. J. WESTCOTT (USAF, Systems Command, Andrews AFB, MD) IN: Environmental integration technology today for a quality tomorrow; Proceedings of the Thirtieth Annual Technical Meeting, Orlando, FL, May 1-3, 1984 . Mount Prospect, IL, Institute of Environmental Sciences, 1984, p. 385, 386.

Use of environmental stress screening (ESS) by the USAF Systems Command to improve the quality of the systems and decrease the life-cycle costs of systems acquisition and development is described. A military ESS standard, which will provide for tailoring and application, is being developed and will be issued in 1984 for the use of ESS on all systems during full-scale development and production phases. Cost-effective tailoring and selection of such stress levels, which will stimulate failure modes consistent with the expected use environment, will be continually monitored. Combined environmental reliabilty (CERT) testing will be used as a basis for TAAF, reliability demonstration, and reliability acceptance. I.S.

A86-22318#
CALCULATION OF MISALIGNMENT ERROR OF MULTI-JOINT HOLES OF WING TO FUSELAGE
Z. CUI (Shenyang Aircraft Corp., People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, Aug. 1985, p. 385-392. In Chinese, with abstract in English.

An error dimensional chain equation for misalignment of multijoint holes of wing to fuselage is discussed in this paper. The equation is derived on the basis of error dimensional chain theory and according to the principle that between any two points a straight line may be drawn, but among more than two points only a broken line can be made. This equation can estimate the coaxiality of joints and the misalignment error in the center location of fork-ear fitting. Therefore, some suggestions for improvement of unjust joining specifications are offered and the evaluation of construction compensation is given. Author

A86-22382
THE AUTOMATED, ADVANCED MATRIX FMEA TECHNIQUE
P. L. GODDARD and R. W. DAVIS (Hughes Aircraft Co., Fullerton, CA) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 77-81.

It is pointed out that the Failure Modes and Effects Analysis (FMEA) is one of the most effective design analysis techniques used in reliability engineering. Thus, a properly performed FMEA can be used to support a wide range of analyses and disciplines. However, FMEA is expensive to perform, and it requires the use of one or more highly skilled analysts. In addition, MIL-STD-1629A, representing tabular FMEA documentation, is not organized in a way which would permit the maximum effective use of all analysis results. The present paper is concerned with the Advanced Matrix Technique which provides a solution to several of the major problems with FMEA. The Advanced Matrix Technique was developed as part of a study of automated FMEA techniques. Attention is given to the objectives of the Advanced Matrix Technique, aspects of technical structure, technical phasing, and the Failure Effects and Data Synthesis computer program, which was developed to automate the Advanced Matrix FMEA technique. G.R.

A86-22384
MAINTENANCE STRATEGIES FOR AERO ENGINES
J. K. BLUNDELL (Missouri, University, Columbia) and K. W. BEARD (Trans World Airlines, Kansas City, MO) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 92-98. refs

In the planned replacement of aero engines, common strategies employ time dependent or block replacement methods. Neither can produce optimal strategies as components tend to be replaced unnecessarily, the beauty of the systems are that they are easy to plan although the number of maintenance actions are often excessive. The paper addresses the development of an opportunistic maintenance strategy for the RB 211 commercial airplane engine which develops planned replacements based on system and component reliabilities and which can interactively determine least cost replacement modes at predetermined inspection intervals. Author

A86-22391#
RELATING FACTORY AND FIELD RELIABILITY AND MAINTAINABILITY MEASURES
P. R. MACDIARMID (USAF, Rome Air Development Center, Griffiss AFB, NY) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 177-183. refs

This paper addresses the issue of field reliability not equaling factory reliability. It overviews Air Force and DOD policy on the issue, reviews previous works on the subject and details current Rome Air Development Center activities related to it, including a recently completed study that developed models translating contractual to operational (and vice versa) R&M parameters. Author

A86-22396
HARDWARE/SOFTWARE FMEA APPLIED TO AIRPLANE SAFETY
J. B. J. VAN BAAL (Nationaal Lucht- en Ruimtevaartlaboratorium, Amsterdam, Netherlands) IN: Annual Reliability and Maintainablity Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 250-255.

Recent changes in the nature of airplane systems have created the need for a systematical and analytical methodology for system safety assessment. Such a methodology is briefly explained. A try-out on a software controlled digital avionics system is described. Special attention is paid to the analysis of the software components of the system. From this work it is concluded that the same

methodology can be applied to both software and hardware. Two conditions that have to be met to perform a successful hardware/software safety assessment are described. Author

A86-22402
IS THERE LIFE AFTER 10,000 FLIGHT HOURS?
T. M. EVANS and D. L. MERKORD (LTV Aerospace and Defense Co., Dallas, TX) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 396-401.
(Contract N00019-80-G-0033; NAVY ORDER 0002)

The possibility of keeping an aircraft in service beyond the predetermined fatigue life limits of its structures is considered, with particular reference to the fleet of A-3 aircraft, which exceeded their wing design fatigue life of 10,000 flight hours. Fatigue test/analysis on an A-3 trainer model is described, including discussions of test requirements, development of the fatigue test loading spectrum, the test setup, and testing procedure. It was found that service life of A-3 fleet aircraft can be extended to 18,000 flight hours and 2000 catapults. The test data verified that theoretical analyses for service life extension are reliable when fatigue-test-derived maintainability items are applied. I.S.

A86-22407
A MULTIPLE-PARAMETER ALLOCATION PROCESS
C. E. TUCKER (Lockheed-Georgia Co., Marietta, GA) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 448-453.

An allocation process has been developed to produce realistic component level requirements on multiple reliability and maintainability (R and M) parameters. The process simultaneously allocates a set of multiple key parametric constraints which are translatable from requirements on parameters such as Weapon System Reliability (WSR), Mean Time Between Removals (MTBR), Maintenance Manhours per Flight Hour (MMH/FH), Mean Manhours to Repair (MMH/R), and Availability. Using component and system total predictions and improvability estimates, the process iteratively selects and allocates incremental improvements to the key parameters and components in need of greatest further improvement to achieve air vehicle or system total requirements, and related parameters are allocated improvements proportional to these. The iterative algorithm, which resembles the method of steepest descent, terminates when all key requirements have been met by the sum total of all incremental improvements selected. A brief example is included which reveals the essential features of the process. Author

A86-22681*# Amtec Engineering, Inc., Bellevue, Wash.
NUMERICAL SOLUTION OF 2-D THRUST REVERSING AND THRUST VECTORING NOZZLE
S. IMLAY (Amtec Engineering, Inc., Bellevue, WA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p. refs
(Contract NAS1-17170)
(AIAA PAPER 86-0203)

The flowfield within and around two dimensional thrust reversing and thrust vectoring nozzles has been calculated using a new unfactored implicit method with a multiple zone grid. Computations are done for fully deployed thrust reversing nozzles, partially deployed thrust reversing nozzles with thrust vectoring, and a nozzle transitioning from partially to fully deployed. Agreement with available experimental data is good. Author

A86-22684#
COUPLING ARTIFICIAL INTELLIGENCE AND NUMERICAL COMPUTATION FOR ENGINEERING DESIGN (INVITED PAPER)
S. S. TONG (General Electric Co., Schenectady, NY) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 11 p. refs
(AIAA PAPER 86-0242)

The possibility of combining artificial intelligence (AI) systems and numerical computation methods for engineering designs is considered. Attention is given to three possible areas of application involving fan design, controlled vortex design of turbine stage blade angles, and preliminary design of turbine cascade profiles. Among the AI techniques discussed are: knowledge-based systems; intelligent search; and pattern recognition systems. The potential cost and performance advantages of an AI-based design-generation system are discussed in detail. I.H.

A86-22690*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
QUANTITATIVE DETERMINATION OF ENGINE WATER INGESTION
P. PARIKH, M. HERNAN, and V. SAROHIA (California Institute of Technology, Jet Propulsion Laboratory, Pasadena) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(Contract NAS7-918; DOT-FA03-81-A-00765)
(AIAA PAPER 86-0307)

This paper describes a novel non-intrusive optical technique for determination of liquid mass flux in a droplet laden airstream. The technique was developed for quantitative determination of engine water ingestion resulting from heavy rain or wheel spray. Independent measurements of the liquid water content (LWC) of the droplet laden aircraft and of the droplet velocities were made at the simulated nacelle inlet plane for the liquid mass flux determination. The liquid water content was measured by illuminating and photographing the droplets contained within a thin slice of the flow field by means of a sheet of light from a pulsed YAG laser. A fluorescent dye introduced in the water greatly improved the droplet image definition. The droplet velocities were determined from double exposed photographs of the moving droplet field. The technique was initially applied to a steady spray generated in a wind tunnel. It was found that although the spray was initially steady, the aerodynamic breakup process was inherently unsteady. This resulted in a wide variation of the instantaneous liquid water content of the droplet laden airstream. The standard deviation of ten separate LWC measurements was 31 percent of the average. However, the liquid mass flux calculated from the average LWC and droplet velocities came within 10 percent of the known water ingestion rate. Author

A86-22700*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FORMATION AND CHARACTERIZATION OF SIMULATED SMALL DROPLET ICING CLOUDS
R. D. INGEBO (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p. Previously announced in STAR as N86-14554.
(AIAA PAPER 86-0409)

Two pneumatic two-fluid atomizers operating at high liquid and gas pressures produced water sprays that simulated small droplet clouds for use in studying icing effects on aircraft performance. To measure median volume diameter, MVD or D sub v.5, of small droplet water sprays, a scattered-light scanning instrument was developed. Drop size data agreed fairly well with calculated values at water and nitrogen pressures of 60 and 20 psig, respectively, and at water and nitrogen pressures of 250 and 100 psig, respectively, but not very well at intermediate values of water and nitrogen pressure. MVD data were correlated with D sub O, W sub N, and W sub w, i.e., orifice diameter, nitrogen, and water flowrate, respectively, to give the expression for MVD in microns. Author

A86-22703*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
DUAL RECTANGULAR JETS FROM A FLAT PLATE IN A CROSSFLOW
M. KAVSAOGLU, J. A. SCHETZ, and A. K. JAKUBOWSKI (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 13 p. NASA-supported research. refs
(AIAA PAPER 86-0477)

Wind tunnel tests were carried out in order to study the single and dual rectangular crossflow jets injected from a flat plate perpendicular to a free stream. The length-to-width ratio of the jets was 3.97, and the spacing between the center lines was 4.7 times the width of a single jet. Surface pressure distributions were obtained for jet-to-freestream velocity ratios of 2.2 and 4, respectively. The following conclusions are offered on the basis of the experimental results: (1) the downstream extension of the negative pressures is extended to the dual jets in comparison to the single jet; (2) by increasing the jet-to-freestream velocity ratio the downstream extension of negative pressures is reduced, but negative upstream pressures become larger; (3) very high peak negative pressures occur at the front side edges of the rectangular jets compared to round jets. Velocity vector plots in the flowfield of the dual jets are given. I.H.

N86-16428# Transportation Research Board, Washington, D.C.
SURFACE PROPERTIES-VEHICLE INTERACTION
D. L. HUFT, I. HER, S. K. AGRAWAL, R. A. ZIMMER, and C. J. BESTER 1984 62 p
(PB85-242576; TRB/TRR-1000; ISBN-0-309-03809-X; LC-85-10046) Avail: NTIS HC A04/MF A01 CSCL 13B

Several topics related to the surface properties of aircraft runways are discussed. The South Dakota profilometer; development of a data acquisition method for noncontact pavement macrotexture measurement; the traction of an aircraft tire on grooved and porous asphaltic concrete; holes in the pavements; the effect of pavement type and condition on the fuel consumption of vehicles; the traction loss of a suspended tire on a sinusoidal road; the effect of vehicle and driver characteristics on the psychological evaluation of road roughness; the correlation of subjective panel ratings of pavement ride quality with profilometer-derived measures of pavement roughness; a microprocessor-based noncontact distance measuring control system, and, the representation of pavement surface topography in predicting runoff depths and hydroplaning potential are discussed. DOE

N86-16486*# ALPHATECH, Inc., Burlington, Mass.
ROBUST DETECTION-ISOLATION-ACCOMMODATION FOR SENSOR FAILURES Final Report
J. L. WEISS, K. R. PATTIPATI, A. S. WILLSKY, J. S. ETERNO, and J. T. CRAWFORD Sep. 1985 220 p refs
(Contract NAS3-24078)
(NASA-CR-174797; NAS 1.26:174797; TR-213-1) Avail: NTIS HC A10/MF A01 CSCL 09C

The results of a one year study to: (1) develop a theory for Robust Failure Detection and Identification (FDI) in the presence of model uncertainty, (2) develop a design methodology which utilizes the robust FDI ththeory, (3) apply the methodology to a sensor FDI problem for the F-100 jet engine, and (4) demonstrate the application of the theory to the evaluation of alternative FDI schemes are presented. Theoretical results in statistical discrimination are used to evaluate the robustness of residual signals (or parity relations) in terms of their usefulness for FDI. Furthermore, optimally robust parity relations are derived through the optimization of robustness metrics. The result is viewed as decentralization of the FDI process. A general structure for decentralized FDI is proposed and robustness metrics are used for determining various parameters of the algorithm. Author

N86-16521# Calspan Field Services, Inc., Arnold AFS, Tenn.
INVESTIGATION OF THE DEVELOPMENT OF LAMINAR BOUNDARY-LAYER INSTABILITIES ALONG A SHARP CONE Final Report, 12 - 15 Feb. 1985
J. C. DONALDSON and S. A. SIMONS Apr. 1985 62 p Sponsored by Air Force
(AD-A159370; AEDC-TSR-85-V16) Avail: NTIS HC A04/MF A01 CSCL 20D

Measurements of mean-flow and fluctuating-flow parameters were made in the boundary layer on a sharp 7-deg cone in an investigation of the stability of laminar boundary layers. The flow fluctuation measurements were made using hot-wire anemometry techniques. Flow field profiles and model surface conditions were also measured. The testing was performed at a free-stream Mach number of 8 for free-stream Unit-Reynolds numbers of 1.0, 2.0, and 3.0-million per foot. The test equipment and techniques and the data acquisition and reduction procedures are described. Analysis of the hot-wire anemometer data is beyond the scope of this report. GRA

N86-16553*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
IMAGE PROCESSING OF AERODYNAMIC DATA
N. D. FAULCON Dec. 1985 15 p refs
(NASA-TM-87629; NAS 1.15:87629) Avail: NTIS HC A02/MF A01 CSCL 14B

The use of digital image processing techniques in analyzing and evaluating aerodynamic data is discussed. An image processing system that converts images derived from digital data or from transparent film into black and white, full color, or false color pictures is described. Applications to black and white images of a model wing with a NACA 64-210 section in simulated rain and to computed low properties for transonic flow past a NACA 0012 airfoil are presented. Image processing techniques are used to visualize the variations of water film thicknesses on the wing model and to illustrate the contours of computed Mach numbers for the flow past the NACA 0012 airfoil. Since the computed data for the NACA 0012 airfoil are available only at discrete spatial locations, an interpolation method is used to provide values of the Mach number over the entire field. Author

N86-16595# Rolls-Royce Ltd., Derby (England).
THE TECHNICAL DEVELOPMENT OF COOLED GAS TURBINE BLADES
S. ROBBINS and H. TUBBS 23 Jul. 1985 85 p refs
(PNR-90292) Avail: NTIS HC A05/MF A01

The history of cooling technology development within Rolls Royce is presented. A list of patents is given. The described systems include those of Conway, Dart, Tyne, Spey and Avon engines. The technical problems related to cost, weight, stress, vibration and performance are discussed. Author (ESA)

N86-16611*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MASS BALANCING OF HOLLOW FAN BLADES
R. E. KIELB 1986 15 p refs Proposed for presentation at the 31st International Gas Turbine Conference, Dusseldorf, West Germany, 8-12 Jun. 1985; sponsored by ASME
(NASA-TM-87197; E-2851; NAS 1.15:87197) Avail: NTIS HC A02/MF A01 CSCL 20K

A typical section model is used to analytically investigate the effect of mass balancing as applied to hollow, supersonic fan blades. A procedure to determine the best configuration of an internal balancing mass to provide flutter alleviation is developed. This procedure is applied to a typical supersonic shroudless fan blade which is unstable in both the solid configuration and when it is hollow with no balancing mass. The addition of an optimized balancing mass is shown to stabilize the blade at the design condition. Author

N86-16613*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STRESS ANALYSIS OF 27% SCALE MODEL OF AH-64 MAIN ROTOR HUB
R. V. HODGES Oct. 1985 49 p refs
(NASA-TM-87625; NAS 1.15:87625; AVSCOM-TR-85-B-8) Avail: NTIS HC A03/MF A01 CSCL 01C

Stress analysis of an AH-64 27% scale model rotor hub was performed. Component loads and stresses were calculated based upon blade root loads and motions. The static and fatigue analysis indicates positive margins of safety in all components checked. Using the format developed here, the hub can be stress checked for future application. Author

N86-16616# Shock and Vibration Information Center (Defense), Washington, D. C.
THE SHOCK AND VIBRATION BULLETIN 55. PART 1: WELCOME, KEYNOTE ADDRESS, INVITED PAPERS, ISOLATION AND DAMPING AND DAMPING PRACTICES Monthly Report
Jun. 1985 169 p refs Proceedings of the 55th Symposium on Shock and Vibration, Dayton, Ohio, 22-24 Oct. 1984; sponsored by ASD 3 Vol.
(AD-A160263; SVIC-BULL-55-PT-1) Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20K

Presented are the welcome address and the keynote address for the 55th symposium on shock and vibration. Also in this section appears invited papers on reliability, damping practics, and damping and isolation. Some article topics include: (1) Avionics Integrity Program (AVIP) air force thrust for reliability; (2) a decade of reliability testing; (3) a different view of viscous damping; (4) passive damping, sonic fatigue and the KC-135; (5) passive load control dampers; and (6) vibration and damping analysis of curved sandwich panels.

N86-16617# Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
AVIP AIR FORCE THRUST FOR RELIABILITY
J. C. HALPIN *In* Shock and Vibration Information Center The Shock and Vibration Bulletin 55, Part 1 p 5-19 Jun. 1985
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 14D

An overview is given of the avionics integrity program. Some history is given as to how and why the program developed. The program concerns itself with the quality assurance and reliability of aircraft electronics. It is believed that the safety of avionics can be controlled by controlling the flaw size distribution and stress levels. Also preventive maintenance is briefly discussed. E.R.

N86-16618# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
DYNAMICS R AND D IN THE AFWAL STRUCTURES AND DYNAMICS DIVISION
J. J. OLSEN *In* Shock and Vibration Information Center The Shock and Vibration Bulletin 55, Part 1 p 21-27 Jun. 1985
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20K

A brief overview of the recent accomplishments, current activities and plans for in-house R&D, contractual R&D and systems support in structural dynamics by the Air Force Wright Aeronautical Laboratories are given. Areas of specific concern are survivable structure, advanced aeronautical structural concepts, aircraft structural integrity, spacecraft structures, and structures and dynamics technology base. Several facilities for research and development in structural dynamics are briefly described. Author

N86-16619# LTV Aerospace and Defense Co., Dallas, Tex. Missiles and Advanced Programs Div.
A DECADE OF RELIABILITY TESTING PROGRESS
R. N. HANCOCK *In* Shock and Vibration Information Center The Shock and Vibration Bulletin 55, Part 1 p 29-41 Jun. 1985 refs
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 14D

At the 45th shock and vibration symposium, which was held at the Dayton Convention Center in 1974, the S&V community was alerted to problems that existed in avionics reliability. A two year study described problems and some proposed fixes. The Air Force programs investigated many actions which are still in progress. The progress that has been made toward the solutions that were proffered at the 1974 meeting are reviewed and some of the tasks that still need development are listed. The problems that were disclosed in 1974 fell into both the technical and the administrative arenas. The latter will be mentioned where lack of action interferes with technical progress, the primary topic. Author

N86-16620# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
CERT: WHERE WE HAVE BEEN, WHERE WE ARE GOING
A. BURKHARD *In* Shock and Vibration Information Center The Shock and Vibration Bulletin 55, Part 1 p 43-49 Jun. 1985
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 14D

Combined Environment Reliability Test (CERT) is discussed where it has been and where the technology is going. What led to the development of this technology is discussed, what has been accomplished, and then what kind of activities and ideas are underway to move beyond CERT. Why was it necessary to develop the concept now called CERT? What is CERT? A thumbnail tutorial on the development of CERT is given, the engineering process one goes through to develop a CERT profile and finally how one might go about applying CERT in a contractual situation. The technology perception challenges that the development and validation of CERT uncovered is described. These are the areas that future development and focus of development efforts need to be undertaken. Author

N86-16625# Dayton Univ., Ohio. Research Inst.
PASSIVE DAMPING, SONIC FATIGUE AND THE KC-135A
P. A. GRAF, M. L. DRAKE, M. P. BOUCHARD, and R. J. DOMINIC *In* Shock and Vibration Information Center The Shock and Vibration Bulletin 55, Part 1 p 89-101 Jun. 1985 refs
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20K

High noise levels occurring during maximum thrust takeoff have caused sonic fatigue cracking of the aft fuselage skin and stringers of the KC-135A aircraft. A program was conducted to solve this problem through the design and evaluation of a passive damping system for the aft fuselage of the KC-135A. A detailed description of the program results is presented. Author

N86-16627# Dayton Univ., Ohio. Rsearch Inst.
A DIFFERENT APPROACH TO DESIGNED IN PASSIVE DAMPING
M. L. DRAKE *In* Shock and Vibration Information Center The Shock and Vibration Bulletin 55, Part 1 p 109-117 Jun. 1985 refs
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20K

In the past, most damping applications were additive designs used to solve field problems. Today, designers are beginning to consider integral (designed in) damping systems. This change in emphasis in damping design will change the market in damping materials. Soon the damping material vendor will be supplying damping materials in bulk form (sheets, rolls, uncured gum) to the structural system manufacturers. Since the damping materials will be required in bulk form, the possibility of ordering a custom formulated material exists. A method is demonstrated which

develops the required damping material properties, discuss formulation changes usable to adjust the damping material properties, and discuss the benefits of such design procedures.
Author

N86-16646# Shock and Vibration Information Center (Defense), Washington, D. C.
THE SHOCK AND VIBRATION BULLETIN 55. PART 2: DYNAMIC TESTING, FLIGHT VEHICLE DYNAMICS, SEISMIC LOADS AND FLUID-STRUCTURE INTERACTION Monthly Report
Jun. 1985 202 p refs Proceedings of the 55th Symposium on Shock and Vibration, Dayton, Ohio, 22-24 Oct. 1984; sponsored by ASD 3 Vol.
(AD-A160264; SVIC-BULL-55-PT-2) Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 01C

Several topics related to dynamic testing, flight dynamics, seismic loads, and fluid-structure interaction are discussed. Shock waves, earthquakes, impact tests, blast loads, aircraft reliability, ship hulls, and submerged bodies are among the topics covered.

N86-16647# Pacific Missile Test Center, Point Mugu, Calif.
TRIAXIAL VIBRATION SYSTEM
W. D. EVERETT and T. H. HELFRICH *In* Shock and Vibration Information Center The Shock and Vibration Bulletin 55, Part 2 p 1-15 Jun. 1985 refs
Avail: SVIC, Code 5804, Naval Research Lab., Washington, D.C. 20375 CSCL 20K

During the reliability tests of external stores the Pacific Missile Test Center has been successful in reproducing the in-service vibration experienced by the store when carried on a high performance jet aircraft. A combination of acoustic and mechanical excitation provides the appropriate vibration magnitude and spectrum. One of the advantages of using acoustic energy has been the simulation of the vibrational state simultaneously in three axes. In attempting to increase test capability to include stores carried on helicopters and other low speed platforms and to maintain a triaxial vibration capability, Pacific Missile Test Center is developing a test facility that will test a 500 pound store in the 0 to 500 Hertz frequency range with a stroke of 2 inches double amplitude. A review of existing low frequency triaxial vibration equipment was conducted, a preliminary design was completed, and individual component and initial developmental model tests were concluded. A description of the device, an overview of the effort to date, an analytical investigation of the motion, and an evaluation test plant was developed for a thorough evaluation of the device are discussed. Author

N86-16674# Welding Inst., Cambridge (England).
FATIGUE TESTING OF TUBE TO NODE BUTT WELDS ENVISAGED FOR RAE BEDFORD FLIGHT SIMULATOR
T. D. ROSENBERG Apr. 1985 30 p refs Prepared for Vickers PLC, Hampshire, England
(REPT-23480/2/85; BR95858) Avail: NTIS HC A03/MF A01

Fatigue tests were carried out on tube to node butt welds under axial loads. Results indicate that the joints can be treated as Class F in the BS 5400 fatigue design rules for welded joints. Pressure drop and leak detection systems for crack detection during the operation of the structure were evaluated. The pressure drop system is found to be effective in detecting the presence of through-thickness cracking. The reserve static strength of a joint containing a single through-thickness crack was measured, and found to be equivalent to a nominal stress in excess of the yield strength of the parent material. Author (ESA)

N86-17296# Kawasaki Heavy Industries, Ltd., Akashi (Japan).
THE ROLE OF COMPUTATIONAL FLUID DYNAMICS IN AERONAUTICAL ENGINEERING
T. UCHIDA, T. JYONOUCHI, K. SAWADA, and T. NOHISA *In* National Aerospace Lab. Proceedings of the 2nd NAL Symposium on Aircraft Computational Aerodynamics p 255-270 1984 refs In JAPANESE; ENGLISH summary
(REPT-2) Avail: NTIS HC A14/MF A01

The task of aircraft design often favors a robust, low-cost computational method rather than a sophisticated one. Examples of such engineering methods currently in use are described in this paper. Included are a viscous-inviscid coupling procedure for a 2-D airfoil at high angle of attack in incompressible flow, a vortex-lattice procedure for not-so-slender wings, and extensions of the FLO22 code so as to incorporate the fuselage- and fluid-viscosity effects. Author

N86-17588# National Aerospace Lab., Amsterdam (Netherlands).
ACTIVITIES REPORT IN AEROSPACE RESEARCH, WITH DATA CONCERNING THE SCIENTIFIC COMMITTEE NLR-NIVR, INTERNATIONAL COOPERATION CONCERNING AGARD, DNW, GARTEUR AND COOPERATION WITH INDONESIA Annual Report, 1984 [VERSLAG OVER HET JAAR 1984. MET GEGEVENS OMTRENT DE WETENSCHAPPELIJKE COMMISSIE NLR-NIVR, DE INTERNATIONALE SAMENWERKING IN AGARD-, DNW-, ETW- EN GARTEUR-VERBAND, EN OMTRENT DE SAMENWERKING MET INODNESIE]
1984 145 p refs Partly in DUTCH and ENGLISH Original contains color illustrations
Avail: NTIS HC A07/MF A01

Aerodynamics, flight, structures and materials, space technology and remote sensing, informatics, environment, energy supply, and equipment, were studied. Research for the Fokker-50 and 100 projects and related development of a measuring, recording, and data processing system for aircraft are described. Damage tolerance of aircraft structures and materials such as carbon/epoxy laminates with outer plies of glass, Aramid and carbon fabric, titanium alloys, and carbon fiber composites, were investigated. Fluid physics research, spacecraft attitude control system tests, and thermal vacuum research were carried out. The development of a multispectral CCD scanner, synthetic aperture radar, and side-looking airborne radar, were studied. A program to integrate aerospace informatics disciplines is described. Air traffic noise calculations, and windpower utilization research were executed. A simulation system for the satellite navigation system NAVSAT was developed. A low-speed wind tunnel LST 3x2.25 was commissioned. Author (ESA)

N86-17637# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de la Physique Generale.
FEASIBILITY STUDY OF A DEVICE TO CONTROL AIRCRAFT ELECTROMAGNETIC PROTECTION [ETUDE DE FAISABILITE D'UN DISPOSITIF DE CONTROLE DES PROTECTIONS ELECTROMAGNETIQUES SUR AERONEFS]
R. C. DAVIDSON and J. L. BOULAY Mar. 1985 43 p refs In FRENCH
(Contract DRET-83-123)
(ONERA-RS-10/3466-PY) Avail: NTIS HC A03/MF A01

Electromagnetic transparence of aircraft structural elements is discussed. Laboratory measurements and parameters composing a wall transparence coefficient are studied. It is shown that an electric conductivity measurement device could be used to deduce the electromagnetic transmission rate. The device should be developed from the CORAS transducer, which measures high range surface resistivity. Author (ESA)

N86-17648# Joint Publications Research Service, Arlington, Va.
ESTABLISHMENT AND USE OF TIME UNIFICATION SYSTEM FOR CIVIL AVIATION
M. M. MALYY *In its* USSR Report: Electronics and Electrical Engineering (JPRS-UEE-84-016) p 30 30 Nov. 1984 Transl. into ENGLISH from Izmeritelnaya Tekhnika (Moscow, USSR), no. 5, May 1984 p 28-30
Avail: NTIS HC A03/MF A01

Precise and fail proof operation of the various services used by civil aviation throughout the territory of the USSR depends largely on synchronization, the latter requiring periodic indication of time scales and involving the concept of time unification. The principal users of a time unification system are the traffic control service and the flight crew. Since 1974 electromechanical hand-and-dial clocks in airports have been gradually replaced with modern signal clocks. Installation of secondary clocks in control towers, time encoding in the secondary clocks, and interfacing the clock room with the computer of the appropriate automatic control system are improvements made in the control tower. Time indicating and time keeping equipment is also installed in airplanes for tie-in with airports by means of radio signals over metric wave or decametric-wave communication channels. The necessary short range radio navigation system with the inclusion of satellites for transmittal of unified time information from airports to airplanes and equipment characterized by satisfactory technical accuracy and high stability with means for automatic or semiautomatic time correction guaranteeing high reliability for a period of 10 years is produced. Author

N86-17666# British Aerospace Aircraft Group, Preston (England). Wind Tunnel Dept.
HOT GAS LABORATORY TWIN NOZZLE CALIBRATION
A. P. WINSTANLEY 1 Jul. 1985 37 p refs
(BAE-ARG-200) Avail: NTIS HC A03/MF A01

The quality of a twin nozzle flow is investigated. The assembly was manufactured to produce high temperature jet related data relevant to VSTOL aircraft when adapted to a wind tunnel hot gas facility. The twin nozzles are of an Ni-resistant flake cast iron construction whereas the standard 120 mm diameter single nozzle is a stainless steel, water-cooled fabrication. A calibration rake was used to acquire pressure and temperature data over an array of data points. The tests show that the construction method is satisfactory. The total pressure quality in the exit plane is good. A negative temperature gradient is found along the y axis. The nozzle reference pressure is a good indication of the average total pressure in the exit plane. Author (ESA)

N86-17699# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
A SURVEY OF NUMERICAL METHODS FOR THE CALCULATION OF INVISCID, POSSIBLY ROTATIONAL EULER FLOWS AROUND AERONAUTICAL CONFIGURATIONS
J. W. BOERSTOEL 11 Oct. 1983 20 p refs
(NLR-TR-83130-U; B8568392) Avail: NTIS HC A02/MF A01

Numerical methods for the calculation of inviscid Euler flows are reviewed. For aerodynamic applications, the existing methods are accurate and cheap enough. However, shocks and vortex sheets may have to be better modeled to achieve higher numerical accuracy. Computation times can be reduced by applying multigrid methods. Author (ESA)

N86-17700# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
BOUNDARY LAYER CALCULATIONS ON THE LEEWARD SURFACE OF A SLENDER DELTA WING AT INCIDENCE
A. C. DEBRUIN 22 Dec. 1983 41 p refs
(NLR-TR-84001-U; B8569025) Avail: NTIS HC A03/MF A01

A 3D-boundary layer calculation method was used to predict the location of the secondary boundary layer separation on the leeward surface of a slender delta wing at incidence for fully laminar flow and forced boundary layer transition at the 50% semispan location. The behavior of the predicted boundary layer properties is qualitatively in good agreement with the experiment. A difference between the potential flow and experimental pressure distribution causes a discrepancy between the predicted and the experimentally observed location of secondary separation. It is expected that the potential flow pressure distribution can be improved when the leading edge and the secondary separation vortex sheet are correctly modeled in the potential flow calculation method. It is concluded that boundary layer calculations can provide valuable information for the location of the secondary separation line, to model the associated vortex sheet. Author (ESA)

N86-17702 Royal Aircraft Establishment, Farnborough (England).
A SMOKE GENERATOR FOR THE ABSOLUTE CALIBRATION OF GAS TURBINE ENGINE SMOKE SAMPLING AND MEASURING SYSTEMS
S. P. GIRLING and C. D. HURLEY Jan. 1985 27 p refs
(RAE-TM-P-1044; BR95024) Avail: NTIS HC A03/MF A01

A smoke generator capable of producing a stable source of smoke over a prolonged period by pyrolysis of aviation kerosene was developed. The smoke levels and characteristics are representative of aircraft engine smoke. The smoke generator provides a means of assessing and calibrating smoke sampling and measurement systems. Accurate gravimetric calibration of SAE smoke number against carbon loading is described. Author (ESA)

N86-17726# Societe Nationale Industrielle Aerospatiale, Saint-Medard-en-Jalles (France).
DESCRIPTION OF A NONDESTRUCTIVE FACILITY USING HOLOGRAPHIC INTERFEROMETRY
P. BARBIER and C. LEFLOCH 1985 6 p Presented at 11th World Conference on Nondestructive Testing, Las Vegas, Nev., 3-8 Nov. 1985
(SNIAS-852-430-105) Avail: NTIS HC A02/MF A01

A holographic interferometry procedure to test aircraft engine use manufactured using composite materials was developed. The equipment includes a laser source, a reading laser, a holographic camera, a chamber in which a depression can be created, and a control panel. The camera is placed inside the structure and revolves through 180 deg to observe the front and rear areas. Photographs of holograms obtained on a sample are presented. A surface of 0.5 sq m may be inspected in 15 min. The economic advantages of the test method are discussed. Author (ESA)

N86-17774# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
QUADRINOMIAL DISTRIBUTION FOR THE CHARACTERIZATION OF NONDESTRUCTIVE INSPECTION (NDI) RELIABILITY
J. H. HEIDA 27 Jun. 1984 17 p refs Presented at 3rd European Conference on Nondestructive Testing, Florence, Italy, 15-18 Oct. 1984
(NLR-MP-84064-U; B8568524) Avail: NTIS HC A02/MF A01

Inclusion of probability of detection (POD) and probability of recognition (POR) of flaws in characterization of nondestructive inspection (NDI) reliability is considered. Possible measures for this characterization are discussed using inspection results of a test specimen population of 200 identical 4340 steel aircraft landing gear components rejected from service because of crack indications or exceedance of the safe service life. It is concluded that it is doubtful whether the discussed parameters give an appropriate measure of NDI reliability; it is recommended to establish minimum values for the POD and POR at a specified confidence level. Author (ESA)

N86-17806# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
DESIGN OF HAT-STIFFENED COMPOSITE PANELS UNDER UNIAXIAL COMPRESSION AND SHEAR. MINIMUM MASS OPTIMIZATION BASED ON A SIMPLIFIED THEORY
G. ROMEO (Polytecnico di Torino, Italy) 1984 46 p refs Sponsored by Technical Hogeschool, Delft
(VTH-LR-312) Avail: NTIS HC A03/MF A01

Literature on stiffened compression panels was reviewed, and a computer program for the evaluation of minimum-mass hat stiffened panels under uniaxial loads was written. In the analytical studies the mechanical properties of the graphite/epoxy material were considered to be linearly elastic and the lower stresses Young's modulus was used. Since a reduction of up to 20% is possible in compression, the 50% mass-saving derived from these results seems too optimistic. A reduced stress-dependent Young's modulus should be used and the tangent modulus theory applied. Better mass-savings are possible with higher hat height values, but these depend on wing airfoil thickness since the optimal distance from the bending neutral axis is required. Under uniaxial compression, a mass-saving up to 40% compared with test data on aluminum panels is evaluated. The fabrication process did not require complex tooling or a difficult production technique. However, complexity could arise for a correct nondestructive inspection of all parts of the panel, because of the closed stiffeners with inclined surfaces. Author (ESA)

N86-17809# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
FATIGUE RATED FASTENER SYSTEMS IN ALUMINUM ALLOY STRUCTURAL JOINTS
H. H. VANDERLINDEN 14 Jul. 1983 29 p refs Presented at 12th ICAF Symposium, Toulouse, France, 25-27 May 1983 Sponsored by Royal Netherlands Air Force Directorate of Material (Contract NIVR-1892)
(NLR-MP-83045-U; B8569323) Avail: NTIS HC A03/MF A01

A fatigue rated fastener systems test program for aircraft is described. The program assesses fatigue lives of fastener systems in combination with hole preparation techniques using different joint geometries. Establishment of cost figures in relation to the fatigue performance and the development of a reference datum for the comparison of test results produced in different countries are included. For high load transfer single shear joints, joint designs and their double shear equivalent designs are compared. Evaluation includes testing under FALSTAFF loading and the measurement of load transfer and secondary bending using standard procedures. Fatigue test results of low load transfer, medium load transfer 1 1/2 dogbone, and high load transfer double shear specimens are also included. Procedures for measuring load transfer and secondary bending are illustrated using 1 1/2 dogbone specimens. Author (ESA)

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A86-19816*# San Jose State Univ., Calif.
AN EXTREME CLEAR AIR TURBULENCE INCIDENCE ASSOCIATED WITH A STRONG DOWNSLOPE WINDSTORM
P. F. LESTER (San Jose State University, CA) and R. E. BACH, JR. (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 8 p. refs
(AIAA PAPER 86-0329)

The meteorological conditions present during an occurrence of clear-air turbulence (CAT) associated with the presence of a mountain wave are documented. The incident caused severe vertical accelerations of two passenger aircraft travelling at 33,000 ft altitude. Satellite, pilot report and surface and upper air meteorological data were examined to characterize the situation. The CAT was apparently produced by an unusually strong westerly flow over the Rocky Mountains, causing a lee wave over the foothill regions where the turbulence was experienced. A downslope windstorm formed at the same time as wave activity on three scales: 60 nm, 17 nm and 1 nm in the troposphere. The data suggest that surface observations of severe windstorms in the mountain foothill regions could be used to predict the presence of CAT conditions, especially if combined with available data on lee waves. M.S.K.

A86-20665
USING A MENU-BASED NATURAL LANGUAGE INTERFACE TO ASK SPATIAL DATABASE QUERIES
C. W. THOMPSON (Texas Instruments Central Research Laboratories, Dallas) IN: Spatial information technologies for remote sensing today and tomorrow; Proceedings of the Ninth Pecora Symposium, Sioux Falls, SD, October 2-4, 1984 . Silver Spring, MD, Institute of Electrical and Electronics Engineers, Inc., 1984, p. 95-101. refs

Menu-based natural language understanding has a number of advantages over conventional natural language interface technology. This paper describes the menu-based approach and discusses some extensions to a domain independent interface generator that allows a user to ask spatial database queries. Author

N86-16749# Rijksluchtvaartdienst, The Hague (Netherlands).
REPORT OF THE WORKING GROUP FOR SENSITIVITY ANALYSIS AND ZONING CALCULATIONS (GAZOB) Final Report [EINDRAPPORT VAN DE WERKGROEP GEVOELIGHEIDSANALYSE ZONERINGSBEREKENINGEN (GAZOB)]
May 1985 91 p refs In DUTCH
Avail: NTIS HC A05/MF A01

The sensitivity of noise pollution calculations to the input data for Schiphol airport was analyzed. Noise pollution calculations for Schiphol airport are reviewed.

N86-16750# Rijksluchtvaartdienst, The Hague (Netherlands).
ANALYSIS AND CONCLUSIONS OF THE WORKING GROUP FOR SENSITIVITY ANALYSIS AND ZONING CALCULATIONS (GAZOB) Final Report
In its Report of the Working Group for Sensitivity Analysis and Zoning Calculations (GAZOB) 42 p May 1985 In DUTCH
Avail: NTIS HC A05/MF A01

The sensitivity of noise pollution calculations to the input data system was analyzed in the area of Schiphol airport with a consideration for housing construction plans, based on the present runway system for the situation expected around 1990 and later. The analysis allows a better insight into the variation of factors which contributes to noise pollution calculations. The only free parameters for the choice of a zone contour are shown to be the fleet composition and the number of aircraft movements. The possible conditions in 1995 and 2000 are calculated and show a substantial noise reduction the planned improvements. It is concluded that a regional zoning for home construction based on the contours calculated for 1990 is justified. Author (ESA)

N86-16751# National Aerospace Lab., Amsterdam (Netherlands). Afdeling Vliegtuigen.
NOISE NUISANCE CALCULATIONS FOR SCHIPHOL AIRPORT ON BEHALF OF THE SENSITIVITY ANALYSIS AND ZONING CALCULATIONS WORKING GROUP (GAZOB) [GELUIDSBELASTINGBEREKENINGEN VOOR DE LUCHTHAVEN SCHIPHOL TBV DE WERKGROEP GAZOB]
H. J. POUTSMA *In* Rijksluchtvaartdienst Report of the Working Group for Sensitivity Analysis and Zoning Calculations (GAZOB) 48 p May 1985 refs In DUTCH
(Contract RB-RLD-1984/1985:5.2)
(NLR-TR-85034-U) Avail: NTIS HC A05/MF A01

Starting points and results of noise pollution calculations for the Schiphol airport are reviewed. Calculation procedure, aircraft data, runway structure, aircraft motions, and test flights are explained. The results of calculations are presented as noise pollution contours. Author (ESA)

N86-16757# Rolls-Royce Ltd., Derby (England). Noise Technology Div.
AIRCRAFT NOISE CONTROL: PROSPECTS FOR THE 21ST CENTURY
M. J. T. SMITH 23 Jul. 1985 10 p Presented at 52nd National Society for Clean Air Conference, Scarborough, England, Oct. 1985
(PNR-90272) Avail: NTIS HC A02/MF A01

The background, policies and prediction of the evolution of aircraft noise control technology are discussed. The probable world fleet composition through to the end of the century is analyzed. Domination of turbofan technology is foreseen by 1988. Examples of recent developments are examined for goals on the order of 95 to 100 dB. Author (ESA)

N86-16843# National Weather Service, Silver Spring, Md. Techniques Development Lab.
AFOS (AUTOMATION OF FIELD OPERATIONS AND SERVICES) MONITORY OF TERMINAL FORECASTS
D. J. VERCELLI and G. A. NORMAN May 1985 33 p
(PB85-236388; NOAA-NWS-TDL-CP-85-1) Avail: NTIS HC A03/MF A01 CSCL 04B

Aviation terminal forecasts (FT's) are issued three or four times per day, depending on location, for selected terminals within the area of responsibility of a Weather Service Forecast Office (WSFO). The FT's contain specific meteorological information on cloud heights and amount, visibility, weather, obstructions to vision, and wind. This information is considered to be the most important to aviation interest in and near the terminal area. A FORmula TRANslation (FORTRAN) program, described by this document, will assist the forecaster with this time-consuming weather-watch function by comparing the information in the FT's with the corresponding information on the surface airways observations. The FT monitoring program, called MONITR makes use of two sets of criteria to determine whether or not a problem exists with a particular FT. In both the amendment and alert cases, the forecaster still has the final responsibility to decide whether or not the FT should be amended. GRA

N86-16854# National Weather Service, Garden City, N.Y.
CERR: AN AVIATION VERIFICATION PROGRAM
M. R. PEROUTKA Apr. 1985 28 p
(PB85-204824; NOAA-NWS-ERCP-30) Avail: NTIS HC A03/MF A01 CSCL 04B

Aviation verification statistics have been computed for Cleveland forecasters since 1980. For most of these years, the computations were done by hand, and a simple statistic had to be developed. The CERR program was developed soon after the National Verification Programs began to run, and it has replaced all the manual computations. The statistic chosen for verification was the average MOS category error. This statistic is simply the absolute value of the difference between the category forecast and the category observed. Scores are computed for each forecaster and guidance at each station for each period forecast. The percent improvement over guidance is also computed. GRA

N86-17816*# Arizona Univ., Tucson. Optical Sciences Center.
SPECTRORADIOMETRIC CALIBRATION OF THE THEMATIC MAPPER AND MULTISPECTRAL SCANNER SYSTEM Quarterly Report, 1 Jun. - 31 Aug. 1985
P. N. SLATER and J. M. PALMER, Principal Investigators 30 Sep. 1985 18 p ERTS
(Contract NAS5-27832)
(E86-10022; NASA-CR-175861; NAS 1.26:175861; QR-11) Avail: NTIS HC A02/MF A01 CSCL 08B

The eleventh quarterly report on Spectroradiometric Calibration of the Thematic Mapper (Contract NAS5-27832) discusses calibrations made at White Sands on 24 May 1985. An attempt is made to standardize test results. Critical values used in the final steps of the data reduction and the comparison of the results of the pre-flight and internal calibration (IC) data are summarized. F.M.R.

N86-17915# National Aerospace Lab., Amsterdam (Netherlands). Afd. Vliegtuigen.
NOISE ASSESSMENT AROUND SCHIPHOL AIRPORT (THE NETHERLANDS) IN 1981 [DE GELUIDSBELASTING ROND SCHIPHOL IN 1981]
J. F. W. BAARSLAG 4 May 1982 24 p refs In DUTCH
(Contract RB-RLD-82-4.1)
(NLR-TR-82034-U) Avail: NTIS HC A02/MF A01

Aircraft noise assessment calculations around an airport are presented. Airport and surroundings are projected on a flat reference surface, on which a 100 m mesh network of points is superimposed. Minimum distances between flight paths and points, maximum noise levels of aircraft per category, and lateral correction factors are determined. Using these data, the number of flight motions, and night penalty factors of aircraft per category, the noise assessment is calculated in cost units with a logarithmic aircraft noise pollution formula. Interpolating between points of equal assessment, noise assessment contours, and areas within are mapped. Author (ESA)

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LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and planetary biology.

A86-19302
COMPUTER TOOLS AND TECHNIQUES FOR ANALYSIS OF DISCRETE DATA FROM AIRCREW AUTOMATED ESCAPE SYSTEMS (AAES)
J. D. FRITSVOLD and J. E. VETTER (U.S. Navy, Analytical Systems Div., Washington, DC) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 37-40. refs

Analyses have been conducted for automated aircrew escape systems, using statistical models generated in part by computer tools to study the significant factors that contribute to problems during ejections or emergency escapes. Extensive use is made in this work of discrete variables that are presented in a frequency table of cross classifications. Significant associations are thereby established, while spurious ones are rejected. The computational capability in question allows the study of the effects of several factors simultaneously on a variable of interest, such as the likelihood of a severe injury or fatality during an aviation emergency. O.C.

A86-19309
U.S. NAVY ALSS CORPORATE REPORT 1984
E. P. VOLLMER (US. Naval Air Systems Command, Washington, DC) and D. N. DESIMONE (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 71-74.

This paper provides an overview of the Navy's Aviation Life Support Systems (ALSS) programs that have entered or completed engineering development. The various development programs show a continued emphasis on escape systems and anti-exposure clothing and equipment and a relatively new development focal point, CBR defense. Additional subject areas addressed include oxygen systems, restraint systems, parachutes and flotation equipment. The current status for each program is detailed, along with planned near-term efforts and, where available, projected contractual efforts. Author

A86-19310
HOW MUCH INHERENT BUOYANCY IS ACCEPTABLE IN A HELICOPTER PASSENGER IMMERSION SUIT
C. J. BROOKS and J. D. M. PROVENCHER IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 75, 76. refs

The buoyancy value of helicopter crewmembers' immersion suits (for hypothermia protection) may be so high as to actually prevent escape from an immersed helicopter's inverted cabin. A recent evaluation of quick-down immersion suits noted a wide range of inherent buoyancies. Attention is presently given to the tradeoffs between inherent buoyancy, hypothermia protection, and underwater escape capability. A 20-lb inherent buoyancy figure is recommended. O.C.

A86-19329
LIMB RESTRAINT EVALUATOR (LRE)
T. GUSTIN (Systems Research Laboratories, Inc., Dayton, OH) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 183-187. USAF-supported research.

The present paper provides a description of a state-of-art data acquisition and recording system which is part of an advanced ejection system test manikin developed by an American company. The manikin is the Limb Restraint Evaluator (LRE), which was designed to test restraint devices to be incorporated into modern aircraft ejection equipment by the U.S. Air Force. The design goals of the LRE are considered, taking into account the successful sensing and capturing of data for 96 phenomena sources for a free-flight test article for the ACES II restraint tests. Difficulties related to the extremely large number of data channels were overcome by employing a Pulse Code Modulation (PCM) type system (time multiplexed). Attention is also given to the use of a low pass filter, a challenge related to telemetry dropout, the selection of onboard storage technique, and the CPU. G.R.

A86-19333
THE EFFECT OF WATER INGRESS ON BUOYANCY AND THERMAL QUALITY OF SURVIVAL SUITS
A. PASCHE (Norwegian Underwater Technology Centre, Laksevas, Norway) and R. ILMARINEN (Institute of Occupational Health, Helsinki, Finland) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 204-207. Research supported by Statoil. refs

Several survival suits have been tested regarding water leakage in the suit during evacuation from a sinking and turned helicopter, total buoyancy for a person dressed in a suit, and the suits insulating properties after evacuation from the helicopter. Water content in the suit followed an evacuation with partly open zippers would be in order of 9-18 kg. Closed-off air in the suit could give some suits a buoyancy in a turned helicopter as high as 40-50 kg. Water leakage into the suits, which is likely to occur, would change the thermal insulation properties of the suits. Even smaller water ingress would have considerably effect on body cooling, while water ingress in a magnitude as established for the evacuation situation result in a very rapid drop in core temperature of the subject (2.0-2.5 C/hour). Author

A86-19336
PROTECTIVE RESPIRATOR FOR THE AAH-64 ADVANCED ATTACK HELICOPTER
D. M. ENGLISH (U.S. Army, Chemical Research and Development Center, Aberdeen Proving Ground, MD) and L. DICKERSON (ILC Industries, Inc., Frederica, DE) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 223-226. Army-supported research.

The present paper is concerned with the background and development philosophy utilized in designing and fabricating a protecting mask system for the U.S. Army AH-64 Attack Helicopter. The very sophisticated weapons and flight systems employed by this helicopter require close optical coupling to various devices. For this reason, current protective masks cannot be used effectively. The U.S. Army issued, therefore, a contract for the development of a protective mask which would interface with the AH-64 Integrated Helmet and Display Sighting System (IHADSS). Attention is given to a description of the AH-64 helicopter, the operational capabilities of the AH-64, mask system requirements, a mask system description, a blower system description, and a program overview. An accelerated development of the IHADSS mask system will allow the U.S. Army to field the AH-64 helicopter on schedule. G.R.

A86-19343
PILOT UNDERWATER HIGH PRESSURE EMERGENCY BREATHING SYSTEM
M. RATAJCZAK (Moog, Inc., East Aurora, NY) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 259-262.

The High Pressure Emergency Breathing System (HPEBS) has the objective to provide life support for an aircrewman in the event of a parachute landing over water. A water activated switch closes the antisuffocation valve in the breathing system, and the HPEBS is actuated. A utilization of the HPEBS increases survival possibilities for an aircrewman in a high sea state. The HPEBS is to provide 500 standard liters of air for consumption. The air is stored in a high pressure spherical vessel. A pyrotechnic actuator and a pressure reducer is also provided. Attention is given to details of pressure vessel design, the pyrotechnic squib, aspects of pressure reducer design, and acceptance level test results. G.R.

A86-19344
LABORATORY AND FLIGHT TESTING OF BALLISTIC PROTECTIVE HEADGEAR FOR ROTARY WING AIRCREW
D. S. MCCAULEY (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 263-268. refs

The results of laboratory and flight tests on two types of ballistic protective gear developed for helicopter aircrew that can be exposed to small arms fire and fragments are reported. The type 1 system is a complete ballistic protective helmet assembly, while the type 2 system consists of a ballistic clip-on unit which can be quickly added to a lightweight, form-fitting helmet. Both systems were shown to meet the ballistic requirements, when tested in accordance with standard requirements of an average ballistic limit, V50, of 1150 ft/s for a 17 grain, 0.22 caliber, type 2 fragment-simulating projectile, and demonstrated good impact resistance. Although most subjects in the flight tests preferred the clip-on system because of weight considerations, the ANVIS ready helmets available to almost all battlefield aircrew are not compatible with a ballistic clip-on bonnet. Therefore, further development of the type 1 system only is recommended. I.S.

A86-19345
THE STATE OF THE ART OF ANTHROPOMORPHIC MANIKINS AND REQUIREMENTS FOR THE EVALUATION OF ADVANCED AIRCRAFT EJECTION SYSTEMS
J. A. TIEBER (Systems Research Laboratories, Inc., Dayton, OH) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 269-275.

A study was conducted to define the capabilities of existing anthropomorphic manikins and the capabilities required of modern manikins to be suitable for the evalution of advanced aircraft escape systems. Specifications for an advanced ejection system test manikin, which resemble and act like a human body when subjected to aerodynamic and inertial loadings associated with aircraft escape conditions, include the simulation of human response to force loadings at various body components, anthropometric accuracy, mass and inertial properties of various body segments, joint articulation, and structural strength. Data acquisition considerations include the type and placement of sensors, number of data channels, data processing and formatting, and on-board storage and/or telemetry requirements. The standard packaging, placement, and environmental protection factors also must be considered. The development of a family of manikins, consisting of an average member and two members representing the fifth and 95th percentiles of the anthropometric spectrum, is recommended. I.S.

A86-19351
EVALUATION OF PILOT PERFORMANCE AND AIRCREW PROTECTIVE DEVICES IN A SIMULATED F-14 FLAT SPIN ENVIRONMENT
J. EYTH, JR. and D. P. GLEISNER (U.S. Naval Material Command, Naval Air Development Center, Warminster, PA) IN: SAFE Association, Annual Symposium, 22nd, Las Vegas, NV, December 9-13, 1984, Proceedings . Van Nuys, CA, SAFE Association, 1985, p. 350-355. refs

A pilot's response to a simulated F-14 flat spin is studied. The F-14 aerodynamic model and the human centrifuge motion platform of the Dynamic Flight Simulator are examined. A spin recovery test is performed to evaluate a pilot's ability to recover the aircraft from the spin and determine what factors influence an unsuccessful recovery. The spin warning display system and restraint system evaluated in the spin test are described. Graphs are provided on the number of revolutions, altitude loss, and recovery time as a function of spin entry condition. The results reveal that higher yaw rates cause an increase in the number of revolution, greater altitude loss prior to recovery of the aircraft, and the pilots are not incapacitated by the high -Gx forces. The spin warning display and restraint systems are highly rated by the pilots. I.F.

A86-22023#
USAF TOXICOLOGY RESEARCH ON PETROLEUM AND SHALE-DERIVED AVIATION GAS TURBINE FUELS
J. A. MARTONE (USAF, Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 4 p. refs
(Contract F33615-80-C-0512)
(ASME PAPER 85-GT-34)

The effect of exposure to the hydrocarbons of aircraft turbine fuels on man is examined. Methods used to establish chemical exposure limits, which include the Threshold Limit Value-Time-Weighted Average (TVL-TWA), TVL-Short-term Exposure Limit (TVL-STEL), and skin notation, are described. The proposed limits for JP-4 are a TLV of 700 mg/cu m, a STEL of 1050 mg/cu m, and n-hexane as a skin notation. Experiments are conducted in which rats are exposed to 2500 and 5000 mg/cu m of JP-4 for 8 months, and 500 and 100 mg/cu m for 90 days. The 8-month data reveal no effect on the rats by the fuel is detected; however, in the 90-day test group reduced weight gain, the formation of hyaline droplets in the proximal tubular epithelium, increased kidney/body weight ratios, and renal carcenoma are observed. The mechanism which causes this hydrocarbon-induced renal effect and its possible influence on man are being investigated. I.F.

A86-22626
A NEW APPLICATION OF ADAPTIVE NOISE CANCELLATION
W. A. HARRISON (Sanders Associates, Inc., Nashua, NH), J. S. LIM (MIT, Cambridge, MA), and E. SINGER (MIT, Lexington, MA) IEEE Transactions on Acoustics, Speech, and Signal Processing (ISSN 0096-3518), vol. ASSP-34, Feb. 1986, p. 21-27. Research sponsored by Sanders Associates, Inc. refs
(Contract NR PROJECT 049-506; N00014-81-K-0742; F19628-85-K-0028; NSF ECS-80-07102)

Widrow et al's (1975) adaptive noise cancellation (ANC) method is applied to the case where an acoustic barrier exists between the primary and reference microphones. ANC, by updating the coefficients of the noise estimation filter only during silence, can furnish substantial noise reduction with little speech distortion even when the acoustic barrier provides only moderate attenuation of acoustic signals. An evaluation is made of a modification of ANC for the oxygen facemasks worn by fighter pilots; if a noise field is created using a single source, an 11-dB SNR improvement is achieved by attaching a reference microphone to mask's exterior. O.C.

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A86-19608
UPSILON INVARIANTS - A UNIFORM SET OF MOMENT INVARIANTS
V. N. DVORNYCHENKO (Northrop Corp., Electro-Mechanical Div., Anaheim, CA) IN: Applications of digital image processing VII; Proceedings of the Meeting, San Diego, CA, August 21-24, 1984 . Bellingham, WA, SPIE - The International Society for Optical Engineering, 1984, p. 40-46. refs

A set of uniform magnitude, minimal-order moment invariants is introduced. The relationship to the Hu and other invariants is explained. It is shown how the present invariants circumvent some of the more serious limitations of the Hu set. For example, it is shown that the Hu invariants are algebraically dependent and how this arises. Graphic representations in the form of hidden-line surfaces in feature space are presented. A proposed basis for 'aspect-independents' is outlined. Author

A86-19821#
CONTROL METHODOLOGY FOR STOCHASTIC SYSTEM CHARACTERISTICS MODULATION
M. N. WAGDI (Suez Canal University, Port Fouad, Egyt) and A. A. ABDEL KADER (Arab Organization for Industrialization, Cairo, Egypt) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 10 p. refs
(AIAA PAPER 86-0335)

A new control methodology for modulation of stochastic system characteristics is presented. Two realistic concepts are introduced. The stochastic behavior of each individual system parameter is considered. This is done by superposing a stochastic part through a small perturbation factor to the nominal deterministic part for each system parameter. The other realistic concept is that of considering the combined dynamics of both plant and actuators. A direct relation between the control gain matrix and the closed loop eigenvalues is derived. A criterion is obtained to insure the control system robustness. The present methodology is applied to the design of a lateral controller for a typical high performance fighter aircraft. Author

A86-19865#
THE ADAPTIVE MANEUVERING LOGIC PROGRAM IN SUPPORT OF THE PILOT'S ASSOCIATE PROGRAM - A HEURISTIC APPROACH TO MISSILE EVASION
G. H. BURGIN, W. H. WILLIAMS, and L. B. SIDOR (Titan Systems, Inc., San Diego, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 9 p. refs
(AIAA PAPER 86-0423)

A real time man-in-the-loop missile evasion simulation is conducted for a fighter aircraft, using a pilot's associate program designated 'Adaptive Maneuvering Logic' (AML) to determine suitable maneuvers on the basis of a set of production rules. In one of the two operating modes of the AML, maneuvering cues are displayed on the pilot's HUD. In the second mode, the AML-generated maneuver commands are fed directly into the flight control system. An illustrative two-missile evasion is presented. O.C.

A86-20518
COMPARISON OF PERFORMANCE CHARACTERISTICS OF DDC ALGORITHMS IMPLEMENTED ON A MICROPROCESSOR
M. R. PATEL and G. COOK (Vanderbilt University, Nashville, TN) IN: SOUTHEASTCON '84; Proceedings of the Conference, Louisville, KY, April 8-11, 1984 . New York, Institute of Electrical and Electronics Engineers, 1984, p. 389-393. refs

This paper presents the study of various digital control strategies, proportional-integral-derivative, deadbeat, and discrete time optimal linear regulator, implemented on a Motorola MC6801 microprocessor and applied to the pitch control of an aircraft. Testing and evaluation was carried out by simulating the aircraft on an analog computer. The digital algorithms performed quite well and the use of the MC6801 microprocessor demonstrated the ease and efficiency with which a digital controller can be realized. Author

A86-20667
UNDERSTANDING NATURAL LANGUAGE COMMANDS
H. H. CHIN (Grumman Aerospace Corp., Bethpage, NY) IN: Spatial information technologies for remote sensing today and tomorrow; Proceedings of the Ninth Pecora Symposium, Sioux Falls, SD, October 2-4, 1984 . Silver Spring, MD, Institute of Electrical and Electronics Engineers, Inc., 1984, p. 106-119. refs

A tunable frame-grammar currently being developed for a Natural Language Control parser is described. How attributes to words and phrases are fitted in the frame structure, and how a pragmatic component helps the parser to choose among competing sentential actions in order to interpret commands correctly, are shown. A pragmatic component which describes the sensibility of a command text in the understanding process is developed. One set of pragmatic rules is used to check the temporal and spatial reasoning of actions, and another set is used to check the state and cause reasoning about goals. Two kinds of ambiguity in the pragmatics are explored in detail. C.D.

A86-22305#
MULTI-KNOT BOOLEAN SUM INTERPOLATING SURFACE INTERACTIVE DESIGN OF AIRCRAFT CONFIGURATION
M. GAO Northwestern Polytechnical University, Journal, vol. 3, Oct. 1985, p. 487-498. In Chinese, with abstract in English. refs

A new kind of modelling tool, a multiknot-based Boolean sum surface, is proposed. Using different Boolean sum operators, more than thirty surface schemes are derived, and the programs of the surfaces are developed for the interactive design of aircraft configuration with computer graphics. The surface interpolating methods are applied to define components of two types of aircraft under development. It is found that they can save as much as 40 percent CPU time compared with B-spline fitting surface. The interactive adjustment of knot parameters is predictable and simple. C.D.

A86-22306#
RECURSIVE INSTRUMENTAL VARIABLE ALGORITHMS FOR MODAL PARAMETER ESTIMATION OF STRUCTURAL SYSTEM
Z. LI, X. LIU, and Y. ZHU Northwestern Polytechnical University, Journal, vol. 3, Oct. 1985, p. 505-514. In Chinese, with abstract in English. refs

In this paper, the Autoregressive Moving Average Exogenous Variables model is constructed for a structural system, and identification techniques called Recursive Instrumental Variable (RIV) methods are used to estimate modal parameters. The methods have good asymptotic properties and are computationally more efficient. They are accurate in the presence of correlated noise and constitute an adaptive processing technique when the noise statistics are not known a priori. A DDF-RIV method which applies RIV techniques to direct decimated data is proposed as a method which efficiently improves the resolution. The performance of the algorithm is illustrated with simulation results, and a vibration test of a one-quarter scale model of a cantilever aircraft wing is used to show the availability of the method. A comparison is made between different RIV, recursive least squares, and frequency domain methods, the results showing that RIV and DDF-RIV methods have some advantages for modal parameter estimation in certain cases. C.D.

A86-22398
SUPPORT EFFECTIVENESS EVALUATION MODEL
N. N. CHANG and J. E. HOWARD (Northrop Corp., Hawthorne, CA) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 322-328.

The present paper provides the description of a model which was designed to evaluate operating and support alternatives in conjunction with the reliability and maintainability characteristics of fighter aircraft operating in the West European Theater. The model is generic in the sense that neither a prescribed air base structure nor a specific type of aircraft is implied. It is the model's objective to evaluate alternate air-base structure according to the criteria of sortie generation, effectiveness, and resource consumption. Both destruction and creation of new operating locations are simulated. Attention is given to hardware and information flows, the operating location data base, a repair capability sensitivity analysis, and model resource requirements. G.R.

N86-16944*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DEVELOPMENT OF A KNOWLEDGE ACQUISITION TOOL FOR AN EXPERT SYSTEM FLIGHT STATUS MONITOR
J. D. DISBROW (Systems Control Technology, Inc.), E. L. DUKE, and V. A. REGENIE Jan. 1986 12 p refs Presented at the AIAA 24th Aerospace Sciences Meeting, Reno, Nev., 6-9 Jan. 1986
(NASA-TM-86802; H-1332; NAS 1.15:86802; AIAA-86-0240)
Avail: NTIS HC A02/MF A01 Palo Alto, Calif.) CSCL 09B

Two of the main issues in artificial intelligence today are knowledge acquisition dion and knowledge representation. The Dryden Flight Research Facility of NASA's Ames Research Center is presently involved in the design and implementation of an expert system flight status monitor that will provide expertise and knowledge to aid the flight systems engineer in monitoring today's advanced high-performance aircraft. The flight status monitor can be divided into two sections: the expert system itself and the knowledge acquisition tool. The knowledge acquisition tool, the means it uses to extract knowledge from the domain expert, and how that knowledge is represented for computer use is discussed. An actual aircraft system has been codified by this tool with great success. Future real-time use of the expert system has been facilitated by using the knowledge acquisition tool to easily generate a logically consistent and complete knowledge base. Author

N86-16989# European Space Agency, Paris (France).
MAXIMUM-LIKELIHOOD ESTIMATION OF PARAMETERS IN LINEAR SYSTEMS FROM FLIGHT TEST DATA. A FORTRAN PROGRAM
E. PLAETSCHKE and D. B. MACKIE Jun. 1985 94 p refs Transl. into ENGLISH of "Maximum-likelihood-Schaetzung von Parametern linearer Systeme aus Flugversuchsdaten - ein FORTRAN-Program" Report DFVLR-Mitt-84-10, Brunswick, West Germany, 1984 Original report in GERMAN previously announced as N85-14588
(ESA-TT-896; DFVLR-MITT-84-10) Avail: NTIS HC A05/MF A01; original German version available from DFVLR, Cologne DM 31

A program for the maximum-likelihood estimation of aerodynamic parameters in linear systems was developed. The mathematical background is outlined. A list of the input data and the flow charts of the main program and the maximum-likelihood subroutine are presented. Practical handling of the program and its options is demonstrated on two examples. The complete main program and comment listings of the subroutines are given.
Author (ESA)

N86-17007# Oxford Univ. (England). Dept. of Engineering Science.
MULTIVARIABLE CONTROL
I. POSTLETHWAITE 1985 22 p refs
(OUEL-1589/85) Avail: NTIS HC A02/MF A01

Multivariable control is introduced with an example (a helicopter model) to illustrate what is meant by a multivariable system and how such systems are modeled. The primary objectives of control and the feedback configurations which can be used to achieve them are discussed. Analysis techniques for assessing the significant properties of a control system design are summarized. Design methods for multivariable systems, and implications of digitally implemented controllers are reviewed. Author (ESA)

N86-17014*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A SIMULATION OF ROTOR-STATOR INTERACTION USING THE EULER EQUATIONS AND PATCHED GRIDS
M. M. RAI (Informatics General Corp.) Dec. 1985 10 p refs
(NASA-TM-86821; A-85376; NAS 1.15:86821) Avail: NTIS HC A02/MF A01 CSCL 12A

An unsteady Euler code to study rotor-stator interaction problem was developed. The code uses patched grids that move relative to each other to simulate the motion of the rotor airfoils with respect to the stator airfoils. The Osher integration scheme is used in conjunction with an implicit relaxation approach. The scheme is second order accurate in space and time, and is also TVD in each spatial direction. The numerical results were found to be periodic in time, thus demonstrating the capability of the integration and zonal schemes in simulating periodic time dependent flow. The pressure contours obtained are almost oscillation free because of the TVD nature of the scheme. A new procedure was developed to simulate flows about bodies that move relative to each other. This capability should prove to be very useful in the areas of rotor-stator interaction, propeller-nacelle interaction, and helicopter rotor-fuselage interaction. Author

N86-17046# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
MARKOV JUMP-DIFFUSSION MODELS AND DECISION-MAKING FREE FILTERING
H. A. P. BLOM 24 Oct. 1983 22 p refs Presented at 6th International Conference on Analysis and Optimization of Systems, Nice, France, 19-22 Jun. 1984
(NLR-MP-83067-U; B8566529) Avail: NTIS HC A02/MF A01

Nonlinear filtering of Gaussian observations of a Markov jump-diffusion with an embedded Markov chain, that is described by Poisson measure is considered. The modeling potential of this class of Markov processes is illustrated by simple realistic examples. For the evolution of the conditional expectation of the Markov process, decomposed representations are given. They are used as a basis to obtain approximate filtering algorithms free of decision making mechanisms. The algorithms are discussed for the examples given. Author (ESA)

N86-18030# National Aerospace Lab., Amsterdam (Netherlands). Hoofdafd. Informatica/Vliegtuigen.
COMPUTER AIDED DESIGN (CAD) AT THE NATIONAL AEROSPACE LABORATORY (NETHERLANDS) WITH THE ACCENT ON AIRCRAFT FLIGHT CONTROL SYSTEMS
W. LOEVE and P. J. VANDERGEEST 24 Mar. 1983 41 p refs In DUTCH; ENGLISH summary Presented at Colloquium Meten en Regelen, Eindhoven, Netherlands, 13 Apr. 1984
(NLR-MP-84032-U; B8568090) Avail: NTIS HC A03/MF A01

The consequences of the integration of CAD-systems within the aircraft industry's infrastructure for information processing and organizational control are elucidated. The possibility to generate the required input for the systems and the usefulness of the output for the design process and ensuing activities are emphasized. It is shown that technical developments with respect to stability and control of aircraft result in the integration of control-technical aspects, alongside those of aerodynamics and structures, within the design process. The development of the tools for designing stability and control systems as part of this integration is described. Author (ESA)

N86-18056# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
AN EFFICIENT FILTER FOR ABRUPTLY CHANGING SYSTEMS
H. A. P. BLOM 25 Jul. 1984 7 p refs Presented at 23rd IEEE Conference on Decision and Control, Las Vegas, Nev., 12-14 Dec. 1984
(NLR-MP-84071-U; B8568106) Avail: NTIS HC A02/MF A01

For a linear discrete time system with coefficients that are governed by an N-state Markov chain, e.g., an aircraft tracked by surveillance radar, a filtering algorithm is defined. It consists of a bank of N interacting Kalman-like filters which communicate with a filter for the Markov chain. When the transition probabilities of the Markov chain are zero, the interacting multiple model (IMM) algorithm reduces to the MM algorithm. Qualitative comparisons with the best other algorithms show an improvement of the ratio between performance and computational complexity up to a factor N. The performance of the IMM algorithm reaches, for small time lags, that of an N times more complex generalized pseudo Bayes algorithm. Author (ESA)

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A86-19790*# United Technologies Research Center, East Hartford, Conn.
ISOLATED AND INTERACTING ROUND PARALLEL HEATED JETS
J. C. SIMONICH (United Technologies Research Center, East Hartford, CT) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 12 p. Research supported by the United Technologies Corp. refs
(Contract NAS1-16689)
(AIAA PAPER 86-0281)

An experimental study of the flowfield of heated and unheated single and dual jet configurations was performed. This study of two parallel jets is unique since most previous aerodynamic structure experiments were limited to single round and two-dimensional jets. The present closely spaced dual jet geometry was motivated by the potential jet noise reduction available from this configuration. This geometry has shown promise as a method

for redirecting jet noise away from ground based observers in side by side or over/under turbofan engine mountings on aircraft (Simonich et al., 1984). Since the effectiveness of this noise reduction technique is based on the existence of two independent jets, an understanding of the aerodynamics of the merging process is essential to establishing the acoustic benefits. The experimental program was structured so that Mach number, jet exit temperature, and spacing to diameter ratios could be independently varied to isolate each effect. Author

A86-20364*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
THE EFFECT OF ACOUSTIC REFLECTIONS ON COMBUSTOR NOISE MEASUREMENTS
R. G. HUFF (NASA, Lewis Research Center, Cleveland, OH) *Journal of Propulsion and Power* (ISSN 0748-4658), vol. 2, Jan.-Feb. 1986, p. 18-24. Previously cited in issue 05, p. 640, Accession no. A85-16103. refs

A86-20795* Missouri Univ., Rolla.
A NUMERICAL MODEL OF ACOUSTIC CHOKING. II - SHOCKED SOLUTIONS
N. J. WALKINGTON and W. EVERSMAN (Missouri-Rolla, University, Rolla) Journal of Sound and Vibration (ISSN 0022-460X), vol. 104, Jan. 8, 1986, p. 81-107. refs
(Contract NSG-3231)

The one dimensional equations of gas dynamics are used to model subsonic acoustic choking. This model can accommodate non-linear distortion of waves and the eventual formation of shock waves. Several finite differencing schemes are adapted to obtain solutions. The results obtained with the various schemes are compared with the asymptotic results available. The results suggest that no one finite differencing scheme gives solutions significantly better than the others and that most of the difference solutions are close to the asymptotic results. If the acoustic shock wave is sufficiently strong it almost annihilates the acoustic wave; in this situation numerical errors may dominate the results. Such solutions involve very large acoustic attenuations. Author

A86-22699*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
SCALING OF HELICOPTER MAIN ROTOR NOISE IN HOVER
C. KITAPLIOGLU (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 24th, Reno, NV, Jan. 6-9, 1986. 15 p. refs
(AIAA PAPER 86-0393)

A 2.1-m-diam, one-sixth-scale model helicopter main rotor was tested in hover at the NASA Ames Outdoor Aerodynamic Research Facility. It had previously been tested in hover in the NASA Ames 40- by 80-Foot Wind Tunnel test section. The primary objective of the tests was to obtain acoustic and performance data on a medium-scale rotor at various thrust coefficients and tip Mach numbers to compare to similar existing data on a full-scale helicopter main rotor. Information is presented on the effects of thrust- and tip-speed variation, the effects of boundary-layer trip strips, and the effects of wind conditions. In addition, a preliminary evaluation of the scaling of helicopter main-rotor noise in hover is presented. A secondary objective was to contribute to a data base that will permit the estimation of facility effects on acoustic testing. Author

N86-17076# Committee on Science and Technology (U. S. House).
NOISE REDUCTION TECHNOLOGY
Washington GPO 1985 135 p Hearing before the Subcommittee on Transportation, Aviation and Materials of the Committee on Science and Technology, 99th Congr., 1st Sess., no. 16, 1 Apr. 1985
(GPO-48-026) Avail: Subcommittee on Transportation, Aviation and Materials

A congressional hearing was conducted and expert testimony heard concerning noise reduction technology as it applied to airports. G.L.C.

N86-17077*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMPARISON OF ADVANCED TURBOPROP AND CONVENTIONAL JET AND PROPELLER AIRCRAFT FLYOVER NOISE ANNOYANCE: PRELIMINARY RESULTS
D. A. MCCURDY Nov. 1985 30 p refs Presented at the 110th Acoustical Society American Conference, Nashville, Tenn., 4-8 Nov. 1985
(NASA-TM-87637; NAS 1.15:87637) Avail: NTIS HC A03/MF A01 CSCL 20A

A laboratory experiment was conducted to compare the flyover noise annoyance of proposed advanced turboprop aircraft with that of conventional turboprop and jet aircraft. The effects of fundamental frequency and tone-to-broadband noise ratio on advanced turboprop annoyance were also examined. A computer synthesis system is used to generate 18 realistic, time varying simulations of propeller aircraft takeoff noise in which the harmonic content is systematically varied to represent the factorial combinations of six fundamental frequencies ranging from 67.5 Hz to 292.5 Hz and three tone-to-broadband noise ratios of 0, 15, and 30 dB. These advanced turboprop simulations along with recordings of five conventional turboprop takeoffs and five conventional jet takeoffs are presented at D-weighted sound pressure levels of 70, 80, and 90 dB to 32 subjects in an anechoic chamber. Analyses of the subjects' annoyance judgments compare the three categories of aircraft and examine the effects of the differences in harmonic content among the advanced turboprop noises. The annoyance prediction ability of various noise measurement procedures and corrections is also examined. Author

N86-17081# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
AEROACOUSTIC RESEARCH IN THE NETHERLANDS RELATED TO AIRCRAFT DEVELOPMENT
W. B. DEWOLF and S. L. SARIN 25 May 1985 11 p refs Presented at 14th ICAS Congr., Toulouse, France, 9-14 Sept. 1984 Sponsored by Netherlands Agency for Aerospace Programs
(NLR-MP-84049-U; B8568094; ICAS-84-5.8.2) Avail: NTIS HC A02/MF A01

For jet noise reduction the feasibility of a lined ejector nozzle for the Fokker F28 aircraft was investigated by scale model measurements using decomposed hydrogen peroxide for hot jet simulation. Thrust performance measurements were included. For the design of optimum acoustic liners a mathematical model was developed to represent the fan and engine duct acoustically, taking into account the sound generation by rotor wake/stator interaction. Acoustic measurements were performed in the engine inlet of a Fokker F28 aircraft during flight. Techniques and facilities were developed for accurate in-situ measurements of the impedance of acoustic liner materials under realistic conditions. The technique was also demonstrated in-flight. Large reductions of the propeller noise level inside the cabin of the Fokker F27 aircraft were obtained by dynamic vibration absorbers on the fuselage wall structure. Author (ESA)

N86-18121*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SEPARATION OF AIRBORNE AND STRUCTUREBORNE NOISE RADIATED BY PLATES CONSTRUCTED OF CONVENTIONAL AND COMPOSITE MATERIALS WITH APPLICATIONS FOR PREDICTION OF INTERIOR NOISE PATHS IN PROPELLER DRIVEN AIRCRAFT Ph.D. Thesis
M. C. MCGARY Jan. 1986 313 p refs
(NASA-TM-87414; NAS 1.15:87414) Avail: NTIS HC A14/MF A01 CSCL 20A

The anticipated application of advanced turboprop propulsion systems and use of composite materials in primary structure is expected to increase the interior noise of future aircraft to unacceptability high levels. The absence of technically and economically feasible noise source-path diagnostic tools has been a primer obstacle in the development of efficient noise control

treatments for propeller driven aircraft. A new diagnostic method which permits the separation and prediction of the fully coherent airborne and structureborne components of the sound radiated by plates or thin shells has been developed. Analytical and experimental studies of the proposed method were performed on plates constructed of both conventional and composite materials. The results of the study indicate that the proposed method can be applied to a variety of aircraft materials, could be used in flight, and has fewer encumbrances than the other diagnostic tools currently available. The study has also revealed that the noise radiation of vibrating plates in the low frequency regime due to combined airborne and structureborne inputs possesses a strong synergistic nature. The large influence of the interaction between the airborne and structureborne terms has been hitherto ignored by researchers of aircraft interior noise problems. Author

N86-18129# Metraflu, Ecully (France).
ANALYSIS OF THE NOISE EMITTED BY A TAIL ROTOR Final Report [ANALYSE DU BRUIT EMIS PAR UN FENESTRON]
M. ROGER, F. FOURNIER, and P. BECKER 11 Jun. 1985 102 p refs In FRENCH
(Contract DRET-83-025)
Avail: NTIS HC A06/MF A01

A two pole tail rotor noise computation method was developed, and an experimental study of diffracting effects on the turbulence generated by the rotor was carried out. The computation predicts the noise spectra of the tail rotor. The parametric study shows that the varying properties of the incident turbulence can give different spectra. The structure design can attenuate noise by up to 20 to 30 dB. Author (ESA)

N86-18130# Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany).
SOUND EXCITATION DURING VORTEX-AIRFOIL INTERACTION
R. TIMM 1985 120 p refs In GERMAN; ENGLISH summary
(MPIS-MITT-80; ISSN-0374-1257) Avail: NTIS HC A06/MF A01

Two-dimensional vortex-airfoil interaction was investigated in experiments and compared with a theoretical model. In a wind tunnel a cylinder generates a Karman vortex street and in a shock tube an asymmetric airfoil generates a starting vortex. Downstream of these vortex generators an airfoil is located. The influence of the vortices on the airfoil flow was investigated by an interferometer. Strong pressure waves originate from the leading edge of the airfoil. The order of magnitude of their amplitude and directional characteristic are experimentally determined. The experimental vortex paths can neither be correctly predicted by the developed model nor by an existing theoretical potential model.
Author (ESA)

N86-18131# Institute for Perception RVO-TNO, Soesterberg (Netherlands). Audiology Group.
APPLICATION OF ACTIVE NOISE REDUCTION FOR HEARING PROTECTION AND SPEECH INTELLIGIBILITY IMPROVEMENT
H. J. M. STEENEKEN and G. LANGHOUT May 1985 23 p refs
(Contract A81/K/145)
(IZF-1985-7; TDCK-93143) Avail: NTIS HC A02/MF A01

Increase of the sound attenuation of an ear protector or a headset by the application of an Active Noise Reduction (ANR) system is discussed. As a result, the risk of hearing damage is decreased, and the quality of the communication increased. Methods to quantify these effects are described. Two ANR systems were evaluated with the measuring methods. It is found that an additional attenuation of 17 dB can be obtained at frequencies or = 500 Hz. It is concluded that the application of ANR systems is advantageous for hearing protection and speech communication in military environments. Author (ESA)

N86-18133# Societe Nationale Industrielle Aerospatiale, Marignane (France). Helicopter Div.
HELICOPTER INTERNAL NOISE TREATMENT. RECENT METHODOLGIES AND PRACTICAL APPLICATIONS
H. J. MARZE and F. N. DAMBRA 1985 15 p Presented at 11th European Rotorcraft Forum, London, England, 10-13 Sep. 1985
(SNIAS-852-210-102) Avail: NTIS HC A02/MF A01

A methodology including helicopter noise diagnosis, definition of acoustic treatment best adapted for each panel structure, and the development, tests and improvements of internal noise treatments is set up. Noise spectra are obtained at several cabin locations and helicopter speeds. An array of noise transducers placed at 120 locations allows to set the acoustic power radiated by each structure subassembly. It is shown that the method gives a good representation the wave pattern, and it may provide sufficient detail to efficiently reduce the added weight of sound proofing treatments. Author (ESA)

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A86-21872#
LIFE CYCLE COST AND AVAILABILITY IN MILITARY AERONAUTICS [COUT DE POSSESSION ET DISPONIBILITE EN AERONAUTIQUE MILITAIRE]
F. LESUEUR (Avions Marcel Dassault-Breguet Aviation, Division Systemes d'Armes, Saint-Cloud, France), A. DEMOMENT (Crouzet, S.A., Division Aerospatiale, Valence, France), and R. ECK (Societe Francaise d'Equipements pour la Navigation Aerienne, Division Pilotage et Systemes, Velizy-Villacoublay, France) IN: International Colloquium on Reliability and Maintainability, 4th, Tregastel, France, May 21-25, 1984, Proceedings. Volume 2 . Lannion, France, Centre National d'Etudes des Telecommunications, 1984, p. 455-459. In French. Research supported by the Service Technique des Telecommunications et des Equipements Aeronautiques.

The present study is concerned with an approach to evaluate the efficiency of a weapons system. A life cycle cost model adapted to the French Air Force is considered, taking into account the costs for study and development, acquisition, and operation. The relative effect of the different parameters is discussed. The concept of operational availability is explored, and the different factors for modelling it are analyzed. Attention is given to hypotheses and limits, the various parts of a mission, the weapons system, maintenance, and aspects of modelling. It is pointed out that the two model concepts for life cycle cost and operational availability represent factors which can be used separately and jointly in the evaluation of a weapons system. G.R.

A86-22076#
OPERATING EXPERIENCE IN THE JEFF (A) IN THE ARCTIC
J. J. EDWARDS (RMI Co., National City, CA) ASME, International Gas Turbine Conference and Exhibit, 30th, Houston, TX, Mar. 18-21, 1985. 6 p.
(ASME PAPER 85-GT-127)

The present article is concerned with studies regarding the use of air cushion vehicles (ACV) in the Arctic. These studies included the use of the Jeff (A), an air cushion landing craft obtained from the U.S. Navy, for operations in Alaska. It is pointed out that the overall performance of Jeff (A) running in the Arctic after the incorporation of relatively few cold weather modifications was truly commendable. The modifications included the use of compliant or low viscosity materials at the operating temperature. In addition, it was found to be important to keep equipment warm, or at least in

a state in which the cooling to extremely cold temperatures would be avoided. After these requirements were satisfied, craft performance became more than satisfactory. In January of 1984, the Jeff (A) initiated cargo service to Mukluk Island in support of drilling activity. G.R.

A86-22141#
AIRFRAME DESIGN TO ACHIEVE MINIMUM COST
B.R. NOTON (Battelle Memorial Institute, Columbus, OH) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 18-1 to 18-11. refs

Cost drivers related to aircraft performance, design, material selection and manufacturing are discussed, and also those related to industry in general. The design objectives and manufacturing technology requirements for low-speed and high-speed aircraft are illustrated to indicate possible cost drivers. The importance of the early developmental phases to reduce cost of engineering systems, is emphasized. To minimize cost drivers, the Air Force has developed a 'Manufacturing Cost/Design Guide' which puts designers on the lowest cost track early in the design phase and also enables trade-off studies to be conducted while developing alternative structural configurations. The methodology used to address cost drivers and to quantify these ae reviewed. Due to problems of cyclic production and stretched-out delivery schedules, some guidance is provided to designers with respect to the importance of learning curves. A worksheet is provided for designers to summarize the cost of parts, subassemblies and the program aircraft. Author

A86-22399
SMALL PROPULSION ENGINE LCC CONSIDERATIONS
P. E. LAUVER (Teledyne, Inc., Teledyne CAE Div., Toledo, OH) IN: Annual Reliability and Maintainability Symposium, Philadelphia, PA, January 22-24, 1985, Proceedings . New York, Institute of Electrical and Electronics Engineers, 1985, p. 348-353. refs

This paper identifies the need to analyze propulsion system cost effectiveness. Current engine life cycle cost (LCC) analysis capabilities are discussed and examples are presented. The differences between aircraft and missile engine LCC factors are identified. Current efforts to address the unique problems of missile engine LCC are summarized. Author

N86-17233# Netherlands Agency for Aerospace Programs, Delft.
ACTIVITIES REPORT IN AIRCRAFT DEVELOPMENT AND ASTRONAUTICS Annual Report, 1984 [VERSLAG VAN DE WERKZAAMHEDEN 1984]
1984 34 p In DUTCH
Avail: NTIS HC A03/MF A01

The Fokker 50 and the Fokker 100 aircraft development activities are reviewed. The data acquisition, recording, and evaluation system for flight tests with prototypes, the Airbus, and the Shorts SD 330/360 is described. Contributions to the IRAS-project; and ESA-programs (telecommunication satellites, Ariane, Eureca, microgravity, Earth observation, Spacelab, Columbus) are summarized. Author (ESA)

N86-18252# National Aerospace Lab., Amsterdam (Netherlands). Informatics and Fluid Dynamics Div.
ENGINEERING DATA INTERACTIVE PRESENTATION AND ANALYSIS SYSTEM (EDIPAS): A GENERAL APPROACH TO ENGINEERING DATA MANAGEMENT AND ANALYSIS APPLIED TO WIND TUNNEL TESTING
R. K. VANDERDRAAI and F. J. HEEREMA 8 Sep. 1983 41 p refs Submitted for publication
(NLR-MP-83057-U; B8566269) Avail: NTIS HC A03/MF A01

Utilizing database management and interactive graphics techniques, the Engineering Data Interactive Presentation and Analysis System (EDIPAS) was designed and implemented for aircraft development. Data management facilities are provided in EDIPAS to cope with the data transfer problem. Basic facilities to tailor analysis and presentation functions to the needs of various disciplines are available. Examples of application of EDIPAS for experiments in wind tunnels are given. Author (ESA)

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GENERAL

A86-22129#
THE WRIGHT BROTHERS EXPERIENCE IN THE EVOLUTION OF AIRCRAFT DESIGN, STRUCTURES, AND MATERIALS
C. A. DEMPSEY (Wright B. Flyer, Inc., Dayton, OH) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 1-1 to 1-13. refs

This paper discusses the work of the Wright Brothers in the evolution of aircraft design, structures, and materials. It describes and gives specific details about their efforts in establishing requirements for the aircraft development program. Influence of the requirements on the new technology development process is discussed with regard to the three axis flight control system, structures, materials, and air vehicles performance. The transition of this technology to later aviation developments is discussed. The paper does not cover the entire Wright Brothers program but clearly defines their procedure in conservative innovation and standardized design technique. It further shows that the 1902 glider (Wright Brothers patent) was the culmination of their research, since this vehicle became the standard for all their other activities. Author

A86-22130#
AIRCRAFT DESIGN - FROM THE MYTH OF MAKE-DO TO MACH 3
R. P. HALLION (USAF, Flight Test Center, Edwards AFB, CA) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 2-1 to 2-5.

The development of aerospace vehicle design technology has always been dependent upon a strong data base derived from analytical studies, ground, and flight research. An examination of the history of aircraft design reveals several major periods from the Wright brothers through the end of the 1950's during which new technological capabilities were developed, refined, and put into practice with both military and civilian aircraft. Author

A86-22135#
THE EVOLUTION OF RECIPROCATING ENGINES AT LYCOMING
A. E. LIGHT (Avco Corp., Avco Lycoming Williamsport Div., Williamsport, PA) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 9-1 to 9-4.

The paper summarizes the history of reciprocating engines at Lycoming from production of automotive engines in 1910 through present production of general aviation engines in 1984. Technical advancements and specification of early automotive, radial aircraft, and present opposed cylinder engines are induced. Lycoming has developed reciprocating engines from 30 horsepower to 5,000 horsepower. Lycoming holds FAA type certificates for over 600 reciprocating aircraft engine models. Author

A86-22137#
X-15 HIGH TEMPERATURE ADVANCED STRUCTURE
J. RAPP (Rockwell International Corp., El Segundo, CA) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 13-1 to 13-3.

The X-15 Advanced Research Vehicle was a design challenge with problems not even envisioned at the outset. The objective was to design and build a manned space flight vehicle capable of very high speed and altitude which could be used to study effects of weightlessness in space. The greatest problem to solve was to select materials to withstand extremely high temperatures to be encountered and then to develop techniques to fabricate and assemble them. Additional structural problems resulted from differential heating of external skins and the sub-structure, which caused a twofold dilemma of secondary induced stresses while simultaneously reducing the allowables. The vehicle also had to have flight control systems that would operate above the atmosphere and after engine burnout. Author

A86-22138#
X-20 STRUCTURES OVERVIEW
A. K. HEPLER (Boeing Aerospace Co., Seattle, WA) IN: Evolution of Aircraft/Aerospace Structures and Materials Symposium, Dayton, OH, April 24, 25, 1985, Proceedings . Dayton, OH, American Institute of Aeronautics and Astronautics, 1985, p. 14-1 to 14-8.

The material and structural development during the X-20 (Dyna-Solar) Program demonstrated the feasibility of a multimission aircraft primary structural system capable of operating at temperatures up to 1650 F. Further, coated refractory alloys were developed for use in leading edge shells and in outer surface panels where temperatures up to 2900 F were experienced. The material and structural design concepts obtained during the X-20 Program represent the bulk of todays (1985) technology for high temperature aircraft structural systems. These validated data provide an excellent source for supporting the conceptual definition of hot structure airframe systems for Advanced Military Aircraft as the Transatmospheric Vehicle (TAV). Author

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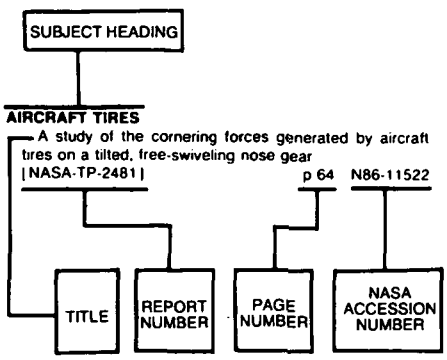

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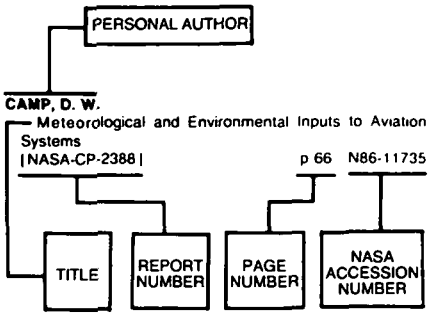

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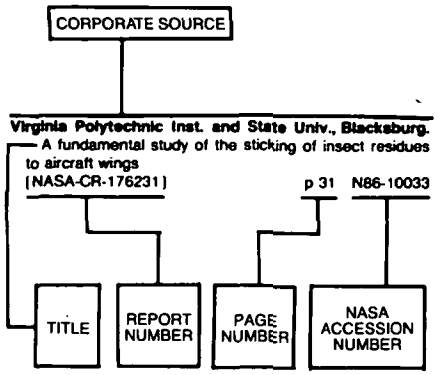

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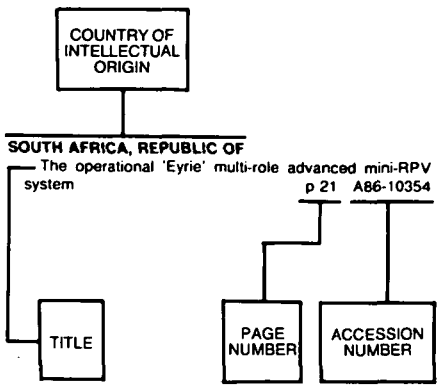

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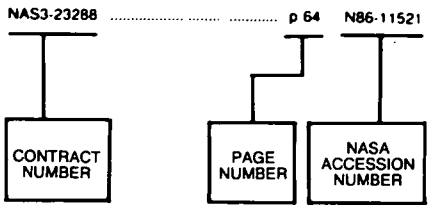

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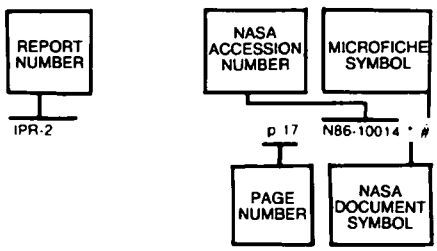

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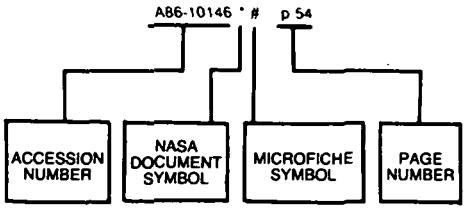

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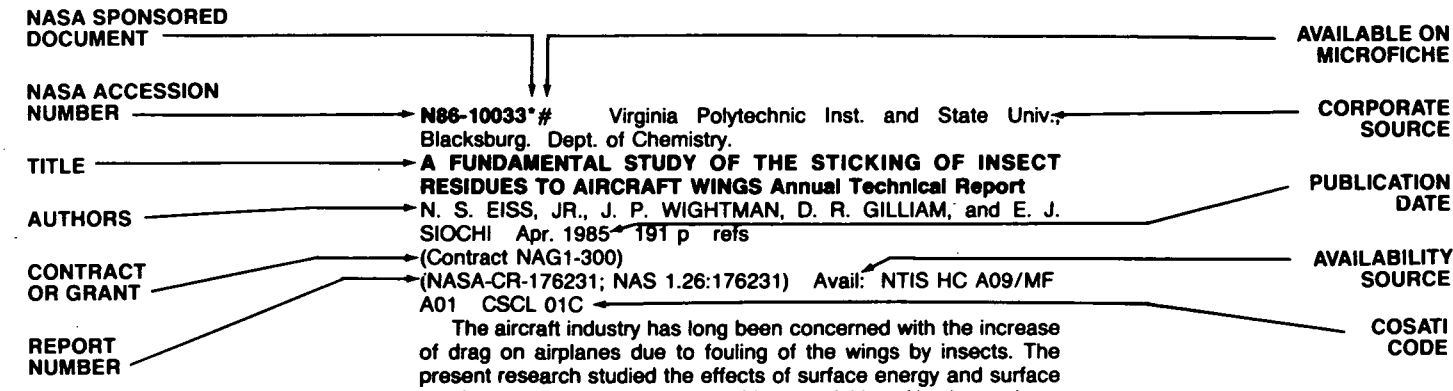

N86-10033*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Chemistry.

A FUNDAMENTAL STUDY OF THE STICKING OF INSECT RESIDUES TO AIRCRAFT WINGS Annual Technical Report

N. S. EISS, JR., J. P. WIGHTMAN, D. R. GILLIAM, and E. J. SIOCHI Apr. 1985 191 p refs

(Contract NAG1-300)

(NASA-CR-176231; NAS 1.26:176231) Avail: NTIS HC A09/MF A01 CSCL 01C

The aircraft industry has long been concerned with the increase of drag on airplanes due to fouling of the wings by insects. The present research studied the effects of surface energy and surface roughness on the phenomenon of insect sticking. Aluminum plates of different roughnesses were coated with thin films of polymers with varying surface energies. The coated plates were attached to a custom jig and mounted on top of an automobile for insect collection. Contact angle measurements, X-ray photoelectron spectroscopy and specular reflectance infrared spectroscopy were used to characterize the surface before and after the insect impact experiments. Scanning electron microscopy showed the topography of insect residues on the exposed plates. Moments were calculated in order to find a correlation between the parameters studied and the amount of bugs collected on the plates. An effect of surface energy on the sticking of insect residues was demonstrated.

Author

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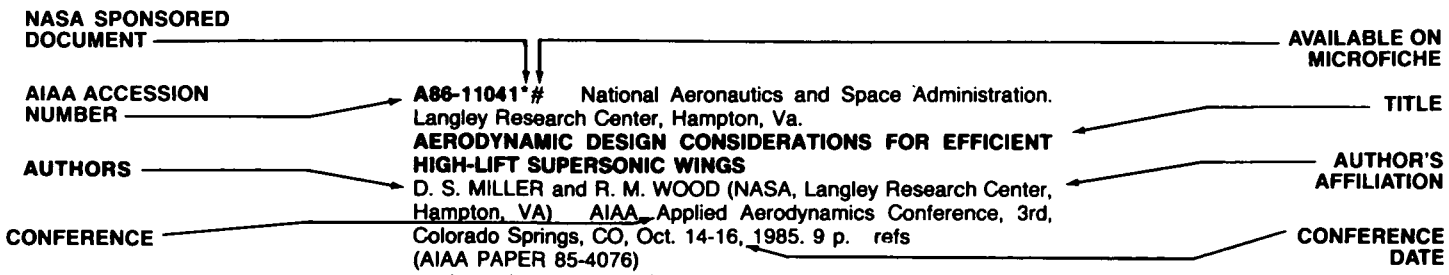

A86-11041*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AERODYNAMIC DESIGN CONSIDERATIONS FOR EFFICIENT HIGH-LIFT SUPERSONIC WINGS

D. S. MILLER and R. M. WOOD (NASA, Langley Research Center, Hampton, VA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs

(AIAA PAPER 85-4076)

A previously developed technique for selecting a design space for efficient supersonic wings is reviewed; this design-space concept is expanded to include thickness and camber effects and is evaluated for cambered wings at high-lift conditions. The original design-space formulation was based on experimental upper-surface and lower-surface normal-force characteristics for flat, uncambered delta wings; it is shown that these general characteristics hold for various thickness distributions and for various amounts of leading-edge camber. The original design-space formulation was also based on the assumption that the combination of Mach number and leading-edge sweep which would produce an equal division of flat-wing lift between the upper and lower surface would also be the proper combination to give the best cambered-wing performance. Using drag-due-to-lift factor as a measure of performance, for high-lift conditions cambered-wing performance is shown to significantly increase as conditions approach the design space; this correlation is demonstrated for both subcritical and supercritical flows.

Author

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